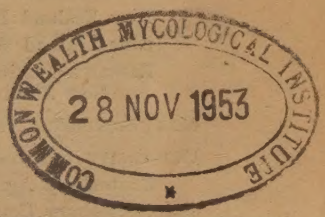
1953
NEW ZEALAND

Twenty-seventh Annual Report of the

Department of Scientific and Industrial Research

Presented to the House of Representatives by Leave



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MINISTER'S STATEMENT

THE report of the Department of Scientific and Industrial Research for the financial year ended 31 March 1953 is presented herewith.

During the year careful attention has been devoted to means for improving the organization of scientific services and research in order to increase the degree of co-ordination and render more effective the effort and expenditure now being made. The Council of Scientific and Industrial Research has had this matter under investigation, and hopes at an early date to submit proposals designed to effect improvements. In view of the fact that the present Act under which the Department operates was framed and passed in 1926, it is reasonable to expect that, taking into consideration the intensive development and changes which have occurred in the intervening twenty-seven years, some reorganization is necessary and will be beneficial.

Despite any shortcomings of the original 1926 Act, it will be readily acceded that the Council and Department, using the authority it provided, have established a scientific organization which has promoted in a large number of directions the prosperity of the Dominion.

The trend of demand for scientific services from State Departments and from industry has during the year continued on an up grade. There is evidence of increasing appreciation of the extent to which science can provide assistance in many problems which would a few years ago have been left aside unsolved or accepted as insoluble.

The results of scientific research are now more than ever being rapidly put into operation. Particularly is this true in the case of the primary industries, where the extension services of the Department of Agriculture bring this new knowledge to farmers and assist in the steps often necessary to ensure it being efficiently put into operation. Similarly in manufacturing, the industrial Research Associations have, through their close connection with the industries with which they are directly concerned, been very effective in bringing the results of scientific effort into practical use.

With the progress of years, the costs of scientific equipment in many fields have increased markedly, and with a view to following a policy of sound economy which will still give the Dominion the benefits of all advances made, close attention has been devoted to methods of improving collaboration within the Department, between various Departments, and with overseas bodies working in allied fields.

A certain measure of direct contact between scientists in New Zealand and their colleagues overseas is regarded as essential, hence each year provision is made for a number of officers to go abroad for study and conferences. Such visits, the employment of Scientific Liaison Officers overseas, and participation in such bodies as the Commonwealth Agricultural Bureaux and the British Commonwealth Scientific Organization have paid handsome dividends in avoiding unnecessary duplication, providing inspiration and collaboration of effort, and keeping New Zealand up to date in scientific matters of importance to the national welfare.

In view of the increased costs of scientific work, some attempt will be necessary to determine priorities both as between existing scientific activities and between proposed new fields of endeavour. It can be said that in the Department of Scientific and Industrial Research there has been organized a good framework of institutions capable of dealing, in collaboration with other bodies, with most of the economic scientific problems of today. With this background to provide general assistance, industries could proceed to establish and promote organizations to deal with the particular problems which concern them, but in a country such as ours it is not likely that it will ever be possible

for us to provide as much money for research as we would wish to make available, and it would seem that the time has arrived for reviewing the basis upon which Research Associations are financed by industry on the one hand and by the taxpaying public on the other.

The Department has continued to maintain a high standard in the scientific services provided to other State Departments and to industry. It has pursued with steady purpose and been successful in the solution of a number of problems requiring research.

I am grateful to the senior officers of the Department for the good quality of the advice tendered to me from time to time, and I am grateful to the members of the staff as a whole for the service they have rendered in the course of their duty and for the general well-being of our community. I appreciate to the full the need for a proper policy of recruitment, and I believe it to be our duty to provide the best remuneration and conditions of service that we can properly afford in order that we can retain in the Dominion a sufficient number of well trained, highly qualified, and enthusiastic scientific workers to cope with the needs of our people.

R. M. ALGIE,
Minister in Charge of the Department of Scientific and Industrial Research.

SECRETARY'S REPORT

The Hon. R. M. Algie, Minister in Charge of the Department of Scientific and Industrial Research.

I have the honour to submit herewith the annual report of the Department for the year ended 31 March 1953.

During the year the Department has continued its functions of (1) providing scientific services to other State Departments and to industry, (2) conducting researches into problems concerned with the natural resources of the Dominion, (3) fulfilling New Zealand's Commonwealth and international scientific obligations, (4) providing grants for the promotion of scientific research at Cawthron Institute and in the University colleges, and (5) undertaking on behalf of the United Kingdom and New Zealand Governments scientific research relating to defence.

In no country of the Commonwealth does the principal State scientific organization undertake a similar range of scientific activities and responsibilities as the New Zealand Department of Scientific and Industrial Research. In most countries the vote is used for research purposes only, and not for the provision of scientific service to other Departments and to industry or for defence science. Abroad, provision is made for scientific services and defence science in separate organizations. In the interests of efficiency and economy it would seem preferable that in New Zealand scientific services, research, and defence science be undertaken in the closest possible association, even at the risk of the full significance of the organization and its financial needs being misunderstood.

In accordance with Government policy, a closer continuous watch was maintained during the year on expenditure in order to make the best possible use of the funds available. It was recognized at the beginning of the year that a state of financial imbalance existed, inasmuch as salaries constituted some 65 per cent of the total vote, whereas in earlier years the percentage varied slightly above or below 50 per cent. A policy was therefore adopted to restore the balance by leaving staff vacancies not filled, and avoiding fresh appointments wherever possible. As a consequence, staff numbers, which were 1,012 at the beginning of the year, fell to 931 by 31 March 1953. The numbers of the professional staff dropped from 402 to 374 during the year. In addition, considerable reductions in capital charges, purchases of equipment and supplies, and travelling expenses were necessary in order to keep within the allocation of £1,020,720. In order to maintain scientific services and research in all existing fields, a policy of spreading reductions as widely as possible—instead of one of entire elimination of work in certain selected fields—was adopted. Elimination of any sphere of scientific activity would have involved dismissal of staff, for the transfer of scientists from one field to another is subject to very severe limitations and would not greatly assist the financial position, since the number and salaries of the staff determines for the most part the total vote of the Department.

The policy adopted was difficult to administer, but nevertheless enabled work to proceed fairly satisfactorily in all branches of activity. It promoted a close examination of all projects being dealt with, their progress, and their worth, their priority and urgency being determined afresh. While the variety of problems undertaken was lessened, the volume was reduced only to the extent of the reduction in the number of scientific personnel that occurred during the year. Whilst it is acknowledged that the reduced allocation in necessitating an exhaustive review of the Department's activities served a good purpose, it is suspected that the implications of a restricted allocation to the Department of Scientific and Industrial Research has not been recognized by those State Departments that have grown accustomed to call upon the Depart-

ment for scientific services. The services in the past have been given readily, and the costs have been met by the Department out of its own vote. The allocations for this year made it difficult or impossible to provide all the free services required by other State Departments and public bodies.

There was evidence during the year that Directors, in their anxiety to keep within their vote, placed restrictions on purchases of material and movements of staff. This is understandable, as many branches are faced with charges that are difficult to foresee or with commitments that may suddenly require to be met. Such uncertainties are vexatious in times when very strict adherence to a fixed allocation is desired.

In this year the Department was granted an allocation of £1,020,720. An analysis of the main purposes for which it was used is as follows:

	Percentage of Total Vote.
(1) Scientific services provided for other Government Departments	22
(2) Research and services to primary industry	17
(3) Research and services to manufacturing industry	7
(4) Grants for research and scientific services to University colleges, Cawthron Institute, and other bodies	5
(5) Grants to Commonwealth and international scientific institutions	3
(6) Applied research on long-term projects	26
(7) Administration, Scientific Liaison Services, publications, Information Service	10
(8) Defence science	10
	100

The preparation of this table has been done critically, taking into account the difficulty that exists in defining what is research and what is scientific service. Research often merges into scientific service, and much that is scientific service often involves some research work. The table indicates that some 22 per cent of the Department's vote is used to provide scientific service to twenty-nine other Government Departments. This includes a great variety of services required for the normal functioning of modern Government activities and obviates the need for each Department providing itself with scientific facilities to meet its own needs. Concentration of scientific staff and facilities in one Department enables very extensive scientific services to be provided on an efficient basis and at an economic cost.

The table also shows that some 26 per cent of the existing vote is used by the Department's Branches for the pursuit of long-term applied research, but the total devoted to research may be assessed as some 43 per cent, arrived at by adding to item 6 (26 per cent) half the percentages of those items (2, 3, and 8) that combine services with research.

In a period when it is necessary to examine closely and critically all financial outlays, it is desirable to review expenditure on scientific services and research with a view to assessing their value in connection with national welfare. Such a review must essentially cover a period of some years, because the results of research are not obtained rapidly and their implementation into practice takes many years to achieve.

Since its establishment in 1926 the Department has received by annual votes a total in all of some £9,233,000 from the Consolidated Fund. During this period recoveries resulting from sales of produce and other income have amounted to some £1,296,000, leaving a net amount of £7,937,000 to represent

the amount of public funds that have been used for scientific service and research purposes. While no assessment has been made each year of the portion of the vote used directly for research, it would be reasonable to assume that the figure of 43 per cent estimated as the figure for the present year would not be very wide of the mark. On this assumption, 43 per cent of £7,937,000, or £3,412,910, has been devoted to research purposes over the past twenty-seven years.

This outlay has made possible the achievement of many results which affect the national prosperity profoundly, and its annual value is very large. Grassland research has enabled New Zealand to attain front rank as a pasture country with an exceptionally high yield of meat, butterfat, and wool per acre. This has been done by breeding new strains of pasture plants and studying their proper management and utilization. It has resulted in large increases in the annual production of fodder, the season of grass growth being extended by at least two months, control of noxious weed growth, and use of new methods of combating such serious diseases as facial eczema and bloat. A considerable export trade has been built up in pedigree grass and clover seeds arising from the efforts of the plant breeders.

Today soil surveys of the whole of New Zealand have been completed—an achievement not attained in any other Commonwealth country. On this basis, areas of erosion, of deficiency in lime and phosphate, of the occurrence of plant and animal deficiency diseases have been mapped, and a foundation established for sound utilization of the Dominion's soil resources, from whence all its wealth is derived. The areas liable to bush sickness—that serious stock ailment that prevented the successful farming of large areas in the Auckland Province—have been defined, and today, thanks to the result of research, these areas can be and are being brought into successful production.

Research into plant diseases has brought many of them under complete control, while others have been made amenable to spray treatment. The fruit-growing industry in particular has been furnished with sound methods for the control of fungus, bacterial, and insect pests such as are not surpassed elsewhere. Bunt and smut diseases of wheat and barley, once of regular occurrence, are now rare.

Research in fruit transport has enabled apples and pears to be sent successfully to the United Kingdom markets without the extensive losses that were common in shipments twenty-five years ago and due to the occurrence of a whole series of storage troubles. Corky core, a very serious physiological disease of apples, especially in Nelson, was, for the first time in the world, shown by New Zealand research to be due to boron deficiency, and it was easily and cheaply remedied. Today the wheat industry, thanks to the plant breeder, has available a series of wheat varieties, Cross 7, Yielder, Fife-Tuscan, and Hilgendorf, which in yield and quality of flour rank equal to the world's best and stand in marked contrast to the dominant Tuscan variety which they replaced.

The two most serious insect pests of pastures, grass grub and grass caterpillar, which injure pasture over millions of acres annually and cause most severe losses, have been brought under control economically as a consequence of entomological research. The diamond back moth, pest of turnips, rape, and cabbage, which in bad seasons inflicted losses estimated at tens of thousands of pounds, has been brought under control, and the white butterfly partially so. Entomological research has indicated methods whereby South African citrus fruit may be imported to New Zealand without danger of introducing serious insect pests from that country.

The phormium industry had long been threatened by yellow leaf disease, a problem which baffled solution until recently, when combined scientific effort revealed its cause and indicated remedial measures. This discovery removed

the worst threat from the industry and one that has completely destroyed phormium over large areas. Research into all aspects of the tobacco industry since 1926 has resulted in the area devoted to this crop being doubled and the yield of leaf per acre being almost doubled, a new type of kiln showing a number of improvements being designed, and effective measures of control over diseases being achieved, all contributing to the result of making prosperous what was originally a struggling industry.

On original research work done in various Branches of the Department, new industries have been established. The linen flax industry was based on research work done at the Agronomy Division, Lincoln; the fish liver oil industry originated from investigations of the vitamin content of New Zealand fish livers undertaken by the Fats Research Laboratory; and the agar industry from seaweed researches undertaken by the Botany Division and the Dominion Laboratory.

Many more advances arising from the research activities of the Department since its formation could be added to this list, but those given will readily suffice the purpose for which they have been quoted, namely, to indicate that the returns from money invested in research in this period have been far greater than the actual outlay, and probably it would not be an extravagant claim to assert that the gains and the prevention of losses in any one year arising from research effort would repay the whole cost of the State expenditure of £7,937,000 incurred in scientific services and research over some twenty-seven years. The results of the past have shown expenditure on research to have been a sound investment. No better confirmation of this is needed than is provided by the confidence shown both by farmers and manufacturers in rapidly applying the results of research in their respective industries. This has been a characteristic feature of the past twenty years in many New Zealand industries.

In previous reports I have on a number of occasions referred to the Department's expectations that a co-ordinated scheme for the organization of building construction research was about to be established. It is regretted that for various reasons it has not been possible to reach agreement on the form of organization required to deal with the many aspects of the building and construction industry. In various Branches, day-to-day problems concerned with building and construction are receiving attention, but this cannot be regarded as constituting an organization adequate to deal with the scientific problems of the building industry in New Zealand. The Department considers that there should be constituted an organization capable of (1) adapting advances made in overseas building research institutions to the special conditions of New Zealand, (2) undertaking research on New Zealand building problems, and (3) disseminating knowledge to the New Zealand building industry.

It is pleasing to record progressive improvement in accommodation in many Branches of the Department. The adaptation of buildings at Gracefield to accommodate sections of the Dominion Laboratory, Dominion Physical Laboratory, and several Research Associations has reduced congestion in Wellington, where additional relief was attained by securing new premises for a section of the Geological Survey and for the Geophysics Division. The housing of the Geological Survey and its records in buildings of non-permanent material, however, constitutes an extraordinarily serious risk to which attention has been drawn many times previously and which was emphasized this year by the destructive outbreak of fire in the Hope Gibbons Building, where serious losses of maps, bulletins, and other records belonging to the Geological Survey and the Soil Bureau were incurred. As the result of successful negotiations for a building in Christchurch, the removal of the Botany Division headquarters to these premises should soon be possible. The more commodious quarters in

Christchurch should bring an end to the extraordinary overcrowding that has unfortunately prevailed in this Division for many years. The new extension in permanent materials of the Grasslands Division building at Palmerston North now under construction will shortly provide much needed relief to the congestion prevailing there since 1940.

It was thought necessary to close the Scientific Liaison Offices in Melbourne and Washington during the year. The Melbourne officer was transferred back to New Zealand, and the officer in charge at Washington proceeded to London to strengthen the staff in that office. A clerical officer will continue in Washington and will be available for transmitting scientific papers between New Zealand and the British Commonwealth Scientific Organization established there.

During the year the Department sustained a serious loss in the death of Dr E. R. Cooper, who at the time of his decease was Assistant Secretary, Physics and Engineering. After a brilliant academic career in New Zealand and in the United Kingdom, Dr Cooper returned to New Zealand in 1939 and was placed in charge of a very small physics laboratory of the Department. This under his direction developed rapidly during the years of World War II to become known as the Dominion Physical Laboratory, the largest branch of the Department. The task of organizing the Laboratory in the difficult war years was a very formidable one, and the success attending Dr Cooper's achievement in this field revealed his remarkable capacity as an organizer and his fine scientific qualities, which earned the profound respect of his colleagues by the high standard of attainment he demanded in many branches of physics and engineering. In 1951 he was appointed Assistant Secretary, and in this position again demonstrated scientific and administrative qualities of a very high order.

Mr W. M. Jones, a former Rhodes Scholar and Director of the Department's Oceanographic Observatory, died towards the end of the year. Mr Jones was a highly qualified mathematical physicist who had undertaken a number of investigations into the problems lying in this field and published papers on them. At the time of his death he was making good progress with the development of the recently established Oceanographic Observatory.

The year has seen a number of achievements in the field of research that will prove of distinct economic value to the Dominion. In the war against plant diseases and insect pests a number of valuable results has been obtained. Tomato growers using hormone sprays to induce setting of the fruit from early flower trusses have found their increased yields reduced through the incidence of botrytis disease. This has resulted in fiancial losses ranging from £300 to £1,000 per grower. Incorporation of a special fungicide with the hormone spray was found to combat this trouble and provide a probable saving of some £30,000 annually to Auckland tomato growers.

Thinning of apples is a costly matter in many Hawke's Bay orchards, and will amount to as much as £15 per acre with many varieties that set fruits in generous amounts. Investigations with the use of hormone sprays have been in progress for some years and now indicate that some 70 per cent of that cost may be avoided and would result in a saving of some £20,000 annually. Moreover, the treatment has shown value in reducing the undesirable tendency for biennial bearing, characteristic of some varieties.

Unusual problems are characteristic of the fruitgrowing districts of Central Otago, and during the year treatment of pears, peaches, and nectarines with zinc salts has checked die back and restored them to normal vigour. Manganese deficiency in apricots, plums, and quinces has been found to be widespread in fruitgrowing areas, and appropriate treatment with manganese compounds has proved very effective. Orchardists in many districts will be obliged to consider

whether unthriftiness in their trees has been due to unsuspected mineral deficiencies.

Investigations on frost injury to fruit trees has provided data which give more reliable information on prediction of dangerous frosts and has enabled a reduction to be made of the time during which firepots should be operated in order to prevent damage. This will lead to economies in the use of fuel and labour.

Pea wilt is a disease that causes serious losses to growers, and as it is a soil fungus it renders soil in which it occurs useless for peas for a period of up to fifteen years. A policy of plant breeding undertaken at the Crop Research Division has resulted in the production of strains of Blue Prussian and Greenfeast peas that are of proved resistance to wilt disease. This will enable farmers not only to get better yields, but will allow them to use peas more frequently in their cropping rotation.

Many years of plant breeding and selection work have failed to produce an oat resistant to lodging, but recently the Milford variety, originally produced at Aberystwyth, has shown that it has strong resistance against lodging.

The occurrence of black root-rot disease in tobacco soils has been an increasing menace in recent years and has resulted in many areas going out of cultivation. The Director of the Research Station introduced a number of varieties from the United States of America, and two of these (Virginia Gold and Vamorr 50) under test in infested ground have shown their capacity to increase yields by over 500 lb. of leaf per acre. This will enable tobacco to be grown profitably on areas now abandoned on account of infestation by root rot.

Control of weeds in seedling beds has been one of the most costly and troublesome problems affecting tobacco growers, who have had to resort to steam sterilization of soil to overcome the weed troubles. Experiments carried out now for some years have shown that inoculation of soil with the chemical methyl bromide is equally as efficacious as steam. The method of use can be operated by growers, and will be particularly valuable to those located in districts remote from steam sterilization plants.

Another saving to the tobacco grower is the result of tests made with the chemical maleic hydrazide, which, applied when the tops are removed, saves all the subsequent considerable labour involved in the removal of lateral shoots.

Stone fruit blast, a disease that causes an annual loss of tens of thousands of pounds and is particularly serious to fruitgrowers in Otago and Canterbury, has been brought under a considerable measure of control as the result of investigations by the Plant Diseases Division using the antibiotic streptomycin as the controllant. This is one of the first cases on record of an antibiotic substance proving efficacious against a disease of plants. Clover establishment on pumice soils in the Wairakei-Taupo area recently laid down in pasture has proved difficult, but nodule bacterial work done by the Plant Diseases Division staff has produced a strain that promotes rapid establishment of clover in these raw pumice soils. A search for strains suitable for red and other clover varieties is now in progress. Other improvements in the establishment of pastures on raw pumice have emerged from joint efforts of the Soil Bureau and the Grasslands and Plant Diseases Divisions.

The attacks of thrips insects on onions have baffled growers and reduced yields considerably, but during the year investigations showed that DDT spray applied as an emulsion gave complete control of the pest.

In Poverty Bay, headsmut disease and cutworm pests have been making serious inroads on yields of maize crops. No means of control apart from grassing down were known. Investigations by the Plant Diseases Division have revealed that both pests can be brought under control by means of a heavy

dressing of fungicide in which an insecticide to deal with the cutworms is incorporated.

During the year the boron diffusion treatment of green timber against wood-boring insects was proved effective and an inexpensive method of treatment evolved. The results come only after many years of difficult original research work done by members of the staff of the Plant Diseases Division.

The first promising lines of a new type of perennial ryegrass in which the defects of the present perennial are missing have been produced by the Grasslands Division. Halving the amount of grass seed in an ordinary pasture mixture has shown its effectiveness in facilitating the establishment of a good balanced pasture sward during the initially difficult stages. Improvement in the carrying capacity of pastures continues as the result of a series of investigations. At the Te Awa hill station a figure of four ewes per acre was attained last year, compared with one wether a few years ago. At Gore, by thorough exploitation of the merits of short-rotation ryegrass, ten ewes and lambs per acre were carried on the best of the pilot scale farmlets. While the problem of bloat has not yet been solved, the controlled grazing method devised by the Grasslands Division has done much to reduce its incidence.

The results of the Entomological Research Station's investigations on the control of grass grub and porina are being applied on an increasing area; 55,000 acres were treated last year, by comparison with 7,000 acres in the previous year. A survey of the situation has revealed that some 800,000 acres are liable to severe damage annually, and probably the loss in New Zealand involved through reduced production and costs of pasture establishment is of the order of £6,000,000. While investigations are still continuing into these two important pasture pests, the Station's recommendations for DDT treatment, costing less than £1 per acre and proving effective for three years, have been substantiated. Meantime promising research is proceeding with parasites of grass grub to deal with the pest in those extensive areas where DDT applications will not be possible.

The economic significance of the work on these two grass pests is considerable.

Detailed soil surveys of the Gisborne Plains, Foxton sands, Canterbury Plains and downlands, and the Heathcote Valley horticultural areas have been completed during the year, and the results of this basic work will be required almost immediately by other organizations directly concerned with problems affecting these areas. On the Kaingaroa Plains and in North Auckland, surveys of afforestation areas to guide in the selection of appropriate species have been completed.

The detailed geological and geophysical surveys of the Wairakei and Te Teko geothermal areas have been completed, and give a general idea of the steam resources in these areas. These will be proved by the drilling operations of the Ministry of Works. Geochemical and chemical engineering investigations of the steam are proceeding, and have revealed an absence of corrosive properties. Surveys are being extended northwards to the Waiotapu area and consideration given to the use of the steam resources now being tapped for the manufacture of heavy water. These investigations, in which five Branches of the Department are collaborating with the Ministry of Works and State Hydro-electric Department and with the United Kingdom Government, constitute one of the Department's major activities.

Two examples are now quoted of important scientific services rendered by the Department during the year which indicate the value to industry and to State Departments of readily available and experienced staff and equipment.

The Department was actively associated in the scientific aspects of the shipment of chilled beef which the New Zealand Meat Producers' Board despatched to London on the *Dominion Monarch*. This was the first shipment of chilled meat since pre-war times. As the result of the satisfactory collaboration between the staffs of the Dominion Laboratory, the Department of Agriculture, New Zealand Meat Producers' Board, Messrs Thomas Borthwick, Ltd., New Zealand Railways, and the Shaw Savill Company, the shipment was completely successful. Scientific data assembled in New Zealand proved useful to the Cambridge Low Temperature Research Station and the United Kingdom Ministry of Food in the tests carried out on the meat on arrival in London.

In 1951 the late Dr E. R. Cooper, aware of the increasing uses of radio isotopes for the investigation of metallurgical problems, decided after much deliberation to recommend the purchase of gamma ray equipment. On the arrival of the apparatus, staff of the Dominion Physical Laboratory were trained in its use. It was most fortunate that this equipment and the knowledge of its use were available in New Zealand when difficulties were encountered in the penstock controls being installed at the Maraetai hydro-electric dam. Gamma rays emitted by radio-active iridium and cobalt were employed to examine all the welds within the metal and to locate flaws. As a result, repairs to the penstock equipment were made in New Zealand, thus avoiding the sending of parts overseas or purchasing new equipment. This expedited the bringing of Maraetai into operation months earlier than would have been the case otherwise.

The Manufacturers' Research Committee during the year has devoted special attention to the organization of Trade Research Groups within the Auckland Industrial Development Laboratories and Canterbury College Industrial Development Department. This will enable New Zealand manufacturing industries that are too small to form Research Associations to participate in and secure scientific guidance in their problems. Several groups are now being organized, and one group, comprising the bacon-curing industry, is already in operation in association with the Dominion Laboratory. The five Industrial Research Associations have had a very successful year, the increase in membership in most Associations providing evidence of the confidence in which they are being held.

A notable feature of the year has been the large output of published scientific work through the pages of the *New Zealand Journal of Science and Technology*, the issues of which have been maintained up to date, and through the increasing numbers of bulletins and scientific books that have been issued.

RESEARCH COUNCIL

The Council of Scientific and Industrial Research held five regular and one special meeting during the year, and maintained a constant review of the projects and finances administered by the Department. The Department is greatly indebted to the Council for its continued interest and for its valuable criticism and guidance in very many matters associated with the promotion of scientific research.

The Council has devoted much attention to reviewing the existing organization of scientific research in New Zealand for the purpose of devising an improved organization to meet the changed conditions that have developed since the orignal Act was passed in 1926.

The Department wishes to place on record its deep acknowledgment of the assistance given very generously in a wide number of fields of activity by the various Advisory Research Committees established by the Council.

The Council's membership as at 31 March 1952 was—

T. Rigg, K.B.E., M.A., M.Sc., F.R.I.C., F.R.S.N.Z. (Chairman).
J. C. Andrews, Ph.D., M.Sc. (Deputy Chairman).
E. J. Fawcett, M.A. (Cantab.).
E. R. McKillop, O.B.E., M.I.C.E.
R. O. Page, D.Sc.
H. D. Purves, M.Sc., M.B., Ch.B.
J. M. Ranstead, Bledisloe Medallist, and Dip., C.A.C.
W. Riddet, B.Sc. (Agric.), N.D.A., N.D.D.
D. F. Sandys Wunsch, M.A. (Oxon), B.Sc. (McGill), M.I.Chem.E., Assoc.Inst.M.M.
F. R. Callaghan, M.A. (Secretary).

EXPENDITURE, 1952–53

The net expenditure for the year was £941,723. The following was the expenditure incurred in the various Branches of the Department:

	£
Head Office	55,684
Research investigations	325,253
Dominion Laboratory	127,116
Dominion Physical Laboratory	182,525
Geological Survey	53,935
Geophysics Division	68,684
Information Bureau, Scientific Liaison Services, and miscellaneous services	74,314
Auckland Industrial Development Laboratories	25,451
Grants to Universities and agricultural colleges	22,810
Grants, statutory and miscellaneous	39,050
Grants to incorporated research associations	34,750
	1,009,572
Less recoveries	67,849
Net expenditure	£941,723

STAFF

Head Office and District Offices (73), Information Bureau (25), Occupational Psychology Research Section (2), Scientific Liaison Services (3), Animal Ecology Section (6), and miscellaneous (10)	119
Dominion Laboratory (138), Fats Research Laboratory (15), and Geological Survey (56)	209
Applied Mathematics Laboratory (14), Botany Division (27), Crop Research Division (39), Entomological Research Station (10), Fruit Research Station (23), Grasslands Division (78), Hop Research Station (3), Plant Diseases Division (53), Soil Bureau (67), Tobacco Research Station (4), and Wheat Research Institute (9)	327
Auckland Industrial Development Laboratories (28), Dominion Physical Laboratory (189), and Geophysics Division (59)	276
Total staff	931

The total staff, including clerical officers, typists, technicians, and professional officers: 931 (892 permanent and 39 temporary). These comprise: professional, 374; clerical, 169; technical, 334; and others, 54.

CONCLUSION

The Department has continued to receive generous co-operation from other State Departments, Cawthron Institute and the University colleges, overseas scientific organizations, and from both farming and manufacturing interests. The good relations that have prevailed have been much appreciated and have greatly assisted the promotion of the Department's objectives.

This being my final report prior to retirement, I wish to express firstly my sincere acknowledgment of the loyal and efficient service that members of the staff of the Department have rendered during the last six years, and secondly my indebtedness to the Council of Scientific and Industrial Research and its Advisory Committees for the assistance and guidance they have generously rendered on all occasions.

F. R. Callaghan, Secretary.

REPORTS FROM BRANCHES

ANIMAL ECOLOGY SECTION

Officer in Charge: Dr K. Wodzicki

RABBITS

Studies on the biology and ecology of the wild rabbit in Hawke's Bay have been continued.

Breeding and Mortality.—Data collected on the breeding of rabbits during 1950–52 have been analysed, and they confirm the preliminary findings reported last year that there is a well-defined breeding season (June to November), when over 70 per cent of the females are pregnant, although on occasion pregnant animals occur at other times. Considerable pre-natal mortality occurs, but despite this the average number of young produced per adult female during the breeding season is about twenty-four. Of these, however, only about five live to reach maturity, i.e., about 80 per cent of the young rabbits die from natural causes. These findings will have some bearing on the future policy of rabbit destruction when the operation of the natural controlling factors is fully understood.

Parasites.—A survey of parasites of the wild rabbit in New Zealand has been published and shows that twenty-one species occur, of which two (*Graphidium* and *Passalurus*) have a restricted geographical distribution, and that certain parasites are of interest also as a possible source of infection of farm animals. An analysis of the work done on a protozoan parasite (*Eimeria stiedae*) showed that severe infections are largely confined to young rabbits, and that its incidence is affected by climate. There is considerable evidence for believing that this parasite causes appreciable mortality, and future research will be directed towards determining whether its effect can be increased by modifications of the existing practices of control and pasture management. Some fundamental research has been also carried out on the distribution of a nematode parasite (*Trichostrongylus retortaeformis*) as a contribution towards an understanding of the factors that control parasitic populations.

Effect of Rabbit Grazing on Pasture.—A pilot experiment demonstrated, under field conditions in Hawke's Bay, that pasture able to carry one sheep to the acre would support about ten rabbits to the acre. It also suggested that heavy rabbit populations favour the establishment of woody species of plants, and thus tend to cause reversion from grassland to scrub. Finally, this experiment revealed that rabbits confined their grazing to areas of short pasture, whereas in long grass they did not thrive.

Population Studies.—Considerable progress has been achieved by the discovery of a simple age indicator that enables the quick distinguishing of rabbits of less than ten months old from the adults. This is of importance for population studies and for the assessment of the efficacy of different control methods. Studies of wild populations with individually tagged animals provided much information on behaviour and movements of rabbits, e.g., it was found that in Hawke's Bay rabbits have a home range with a radius of about 100 yards, and no evidence of migration was found. Further work has been carried out to test the reliability of census techniques—such as dropping- and sight-counts—with the ultimate aim of checking the efficacy of control measures. A long-term study of the fluctuations in density, changes in the range of rabbit populations, and the effectiveness of control methods used in the Dominion has been continued with the co-operation of the Rabbit Destruction Council. A comparison with the information obtained from surveys in

1946–47 and 1950–52 suggests that at present the rabbit population is at the ebb of an eleven years' cycle.

GENERAL

A bird census was undertaken on the Three Kings Islands in conjunction with the Auckland Institute and Museum. The results of this work will form a basis for tracing future changes in the birdlife of the island now that the goat population has been removed; the information should be of value in devising better methods for protecting rare native birds. Further work has been done on various aspects of the ecology of blackbirds, harrier-hawks, magpies, and gannets.

PUBLICATIONS

Seven papers by members of the staff have been published or accepted for publication.

APPLIED MATHEMATICS LABORATORY

Director: Mr I. D. Dick

The Laboratory has had to undertake a wide variety of work for various branches of the Department and for other State Departments; some of the more interesting experiments are noted below.

Diffusion of Liquids Through Green Timber.—Workers at the Plant Diseases Division had found experimentally certain empirical relationships regarding the rate at which boron solutions diffused through a block of wood. These relationships are of obvious importance for the correct handling of the boron diffusion process, which is a preventative of attack by wood-destroying insects and fungi. The Applied Mathematics Laboratory was able to show that these relationships were theoretically sound, and thus helped to put the work on a more solid basis.

Flood Discharges.—For the most efficient design of hydro-electric dams it is necessary to have some knowledge of the greatest flood likely to confront the proposed dam in, say, the next hundred years. The theory behind this calculation has certain inadequacies, one of which the Laboratory has been able to remedy for the engineers in the State Hydro-electric Department.

Aphid Populations.—Work by the Plant Diseases Division on the damage caused to vegetable crops by aphids has shown that more information on and understanding of the growth of aphid populations will be required if experiments to reduce the damage are to be conducted and analysed most efficiently. This Laboratory and the Plant Diseases Division are collaborating fruitfully on this problem.

Academic Records of Science Graduates.—All the data have been collected and analysed. The results are very valuable both to the Department from the point of view of recruitment, etc., and to the University of New Zealand because it is the first time, for example, that for any faculty such matters as the percentages of incompleted courses, etc., have been investigated in any detail.

Paint Tests.—The Laboratory undertook the statistical analysis of six years' records of paint tests, which were designed by the Dominion Laboratory to give information on the durability and other important characteristics of a variety of paints exposed to diverse climatic conditions.

Parasites in Rabbits.—One way the Animal Ecology Section is attempting to find out causes of mortality of rabbits is the examination of the parasites that infect rabbits in the wild state. The analyses of the records on more than four thousand rabbits, dissected by the Animal Ecology Section, were made by the Applied Mathematics Laboratory.

Publications.—An account of the work of the Laboratory is being written and several papers will be presented for publication in the next financial year.

AUCKLAND INDUSTRIAL DEVELOPMENT LABORATORIES

Director: Mr J. B. Brooke

Industrial work based on service to groups or organizations rather than to individuals would allow more economic use to be made of the Laboratories' scientific staff and a more stable and constructive programme to be implemented. To this end, a number of research groups and associations have been considered in which the industry or group will provide half the yearly cost. The first of these has been a Fuel Technology Group, covering those manufacturers who have a common fuel problem. Following this, an Instrument Technology Service, and a co-operative non-industrial group covering medical instrumentation, are being planned. Support from industry has been readily forthcoming, and it is hoped that the scope of these group organizations will be widened as staff and equipment permits.

GROUP PROJECTS

Fuel Technology.—In the Auckland Province approximately 600,000 tons of coal are burnt annually, and an increase of 2 per cent efficiency in utilization would effect an annual economy of £50,000. A Fuel Technology Group is being formed that aims at promoting research on fuel burning and the economic use of heat, encouraging and improving the education of personnel engaged in industries using fuel, disseminating information relating to the use of fuels, and co-operating with other organizations set up elsewhere for similar purposes. Initial meetings have ben held of industries concerned.

Instrument Technology.—The Laboratories have been called upon to assist many Auckland industries in instrumentation problems. It is considered more economic to handle such work on a group basis, thereby achieving continuity of effort and enabling like problems to be investigated on a collective basis. The Instrument Technology Group in process of formation has the following aims: to carry out factory surveys with a view to improving process control, inspection, counting and indicating; to provide for regular inspection, calibration, and servicing facilities; to provide up-to-date information to members on all matters relating to instrumentation; and to provide equipment for problem analysis. Discussions have been held with a number of firms, the majority of which have signified their willingness to take part in the proposed scheme.

Medical Instrumentation Group.—During the past five years these Laboratories have been engaged in the development of equipment for specialist medical groups in the Auckland area, particularly the cardio-surgical unit at Green Lane Hospital, Auckland. During 1952 the officer in charge of this work visited medical institutions in the United States, Canada, United Kingdom, and Europe to study current developments in medical instrumentation. His investigations confirmed that at overseas institutions this work is also in the development stages and the equipment on which this work has been done or is proposed is not commercially available. These laboratories are in some respects in advance of overseas development. Attempts are therefore being made to ensure the continuation of this medical instrumentation work by organizing a co-operative group in which a proportion of the development costs would be contributed by the Auckland Hospital Board, or from research funds that may be available for such purposes. The medical instrumentation work is carried on in the Electrical Section, under which heading information on individual projects is given.

Flow Measurement.—A commercial pipe-tapping machine was modified to allow insertion of a pitot-static head into a pipe line under pressure. This enabled a flow measurement to be made on a 4 in. water main at 40 lb. per square inch pressure without interfering with the flow.

Hayssen Carton Wrapping Machine.—Wrapping of quick-frozen foods was previously done with waxed paper over a printed carton. A more attractive pack was made possible by using a printed wrapper over a plain carton. Printed wrappers are now supplied in rolls, and the wrapping machine was modified and fitted with a photo-electric control equipment to maintain register of the printed wrapper with the carton.

Stirrup Bending Machine.—Large quantities of steel bar stirrups are used to secure reinforcing in position in concrete work. A machine has been designed for automatic production of stirrups from 6 in. to 2 ft. long, with four or five bends, and in bar sizes from $\frac{3}{16}$ in. to $\frac{1}{2}$ in. diameter. The machine is being built by the firm concerned and is near completion.

Furnace Charger.—An hydraulically operated machine for charging up to 2½-ton loads into a furnace was examined. Stresses were checked and recommendations made for modification and water cooling. The machine is now operating satisfactorily.

Vibration Type Clothes Washer.—Causes of erratic operation of these machines were investigated and suggestions made for improved control during manufacture. Control involved standardization of elastic properties of the assembly by jig machining of components, and care in manufacturing of spring strips and supports. Such control ensures repeatable performance when assembled, and eliminates troublesome adjustment and tuning of individual units.

Circular Saw Vibration.—A commercial saw bench using 18 in. diameter saws at 3,000 r.p.m. was extremely noisy, and vibration caused rough cutting. A check was made with a microphone pick-up and sound analyser. Speeds and frequencies of critical and minor resonance effects were observed. A theoretical examination along the lines of turbine disk practice gave figures in close correlation with those observed. There were no defects in the construction of the bench, but the noise and vibration were due to " standing wave " phenomena inherent in running a saw of such dimensions at such a speed. The trouble was eliminated by cutting five gullets in the edge of the saw.

Embossograph.—Preliminary investigations have been carried out into the design of this machine, which would be used for raised printing. Initial work was concentrated on determining methods of applying the necessary heat to the coloured powders used in the process.

Testing Machine for Pipe Fittings.—A pneumatically operated machine was designed for clamping and pressure testing cast pipe fittings. The firm concerned built the machine and it has performed satisfactorily.

Schiefer Abrasion Testing Machine.—The need for such a machine arose from work being carried out for various firms. The design and drawings after a design by Schiefer, of the U.S. National Bureau of Standards, have been completed. The machine may be used to test wear of carpets, woven fabrics, felts, flooring materials, tiles, concrete, rubber, and most plastic materials. The machine has yet to be built.

Tile Testing Machine.—A large number of concrete tiles are being tested, for compliance with specifications, by the Metallurgy Section, and a need arose for a special purpose machine. This has been completed and is in regular use.

Spray Nozzles.—These were required to form a flat spray for covering with a depillatory skins spread on a conveyor belt. The spray is both corrosive and

abrasive. An experimental nozzle was designed and installed. Following trials, a further six nozzles to a modified design were supplied and appear to be proving very satisfactory. This method of applying the depillatory has replaced hand painting methods.

Educational Aids.—A tool-post dynamometer was made for Seddon Memorial Technical College. This is used to demonstrate to senior apprentices the variation in stress set-up in tools when using different tool angles, cutting speeds, and materials. The unit consists of a special tool holder on which are mounted strain gauges. It is used in conjunction with a Philips A.C. resistance strain gauge bridge

Miscellaneous.—Assistance was given to the staff of the Danish research ship *Galathea* in calibrating two bathythermographs while the ship was in Auckland. A technical note is being prepared on the utilization of low-grade heat in steam turbines.

PHYSICS SECTION

Portable Unidirectional Seismograph.—A vibrograph, similar to that used for experimental work by Imperial Chemical Industries, Ltd., was constructed in the instrument shop. Several modifications were made to simplify its use in the field. The instrument was calibrated on a shaking table at the Dominion Physical Laboratory. During the past few months use has been made of this instrument to take a series of records of ground vibrations due to quarry blasting. As a result of this a new blasting technique has been adopted by the firm concerned. Checks are being made to see that this technique is resulting in reduced ground vibrations for given charges.

Survey of Dust in Dairy Sheds.—The operation of a milking machine involves drawing in air with the milk to assist its transport along the piping. If this air contains dust, the milk is contaminated. In conjunction with Ruakura Research Station, equipment has been built to sample and collect dust from the air entering the milking machine. Field tests are now being made to determine how many and what type and size of particles are drawn into the machine.

Absorption Refrigerators.—An investigation was made into locally manufactured small domestic absorption refrigerator units. These were found to be unsatisfactory in both design and manufacturing technique. Although some success was obtained with modifications the units are still erratic in operation.

Deodorization.—Assistance was given to a firm in carrying out experiments to remove objectionable odours given off during a production process. Information obtained from these pilot experiments is to be used to design full-scale equipment to remove any nuisance caused by the odours.

Testing Station for Domestic Hot-water Cylinders.—The Auckland Electric Power Board have built a station for testing the standing heat loss of thermal storage hot-water cylinders. The Department took part in discussions on the design of this station, and recently examined the completed installation and procedure. The Department has approved the installation as being satisfactory for determining standing heat losses as laid down in N.Z.S.S. 720.

Investigations Into Possible Geothermal Activity in Auckland Area.—On behalf of the Geological Survey, temperature measurements were made at various points in the Auckland area where geothermal activity was reported.

ELECTRICAL SECTION

Medical Instrumentation

Recording Oximeter.—Preliminary development work was done on equipment for recording the oxygen saturation of arterial blood, in cases of congenital

heart disease, by measuring continuously the ratio of light transmitted at two selected wave lengths by the pinna of the ear. The equipment incorporates recent overseas developments as well as novel features.

Experimental Aortic Valve.—A substitute plastic valve for insertion in the aorta has been developed. This eliminates the present overseas method of cutting this vessel and tying its ends to the valve, and at the same time reduces the size of the artificial valve. Problems of insertion and clotting have not yet been solved.

Equipment for Reducing Systemic Blood Pressure During Cranial Surgery.—A pair of perspex chambers have been built to enclose the lower limbs and to seal them by interchangeable rubber lips. The pressure in the chambers is reduced, resulting in the pooling of blood in the venous system of the limbs. This in turn results in the lowering of arterial pressure and the reduction of haemorrhage during the critical phases of brain surgery.

Phrenic Nerve Stimulator.—Two instruments have been constructed along similar lines to that developed at St. Mary's Hospital, London, for the electronic stimulation of respiration. This equipment is of particular application to new-born infants who fail to breathe at birth; several lives have been saved by this simple equipment, and the very real danger of brain damage due to lack of oxygen at birth is removed.

Operating Cardioscope.—An instrument has been designed and made for viewing directly the mitral valve and other internal structures of the living heart. The instrument retains the contact vision principle, utilizing the light-transmitting properties of solid perspex. Built into the instrument is a remotely controlled knife so that examination and surgical repair may be carried out at once. It is hoped to use the instrument eventually for mitral valvulotomy in humans.

Other Developments.—These include an experimental special knife for introduction into the heart for operation on the mitral valve; an X-ray cassette changer of novel design to enable a series of exposures to be made at the rate of two per second; a miniature non-rebreathing valve for use in research on lung volumes and related problems; equipment for the reduction of basal metabolism rate; swivel adaptors for catheters; a blood-film spreader; a hypodermic syringe separator that allows two solutions to be drawn into a hypodermic syringe simultaneously and prevents mixing; and double cells for a Beckman spectrophotometer.

Silicone coatings to prevent blood clotting have been investigated, and a timing apparatus for controlling exposure intervals in the X-ray examination of neuro-surgical cases has been built. Assistance has been given with the installation and operation of an electroencephalograph at the Auckland Hospital, and an electromyograph at the Health Department Hospital at Rotorua.

General Electrical Investigations

Investigation of Corrosion-prevention Methods in Wharf Construction.—Investigations have been made into the design of a system of cathodic protection for a proposed steel sheet pile retaining wall, which is in contact with sea water on one side and earth fill on the other. A report is in course of preparation.

Cathodic Protection of Naval Vessels.—In co-operation with the Dockyard, a system of cathodic protection for naval vessels held in reserve is being investigated. If this proves satisfactory, the scheme will be extended to include active vessels.

Chronograph.—Time intervals from 1 second to 0·0001 second can be measured on a chronograph built for the Underwater Research Laboratory. This electronic device records the time intervals on meter indicators.

Location of Reinforcing in Concrete.—To assist a local engineer investigating the cracking of floor slabs and beams in a building, a check was made on the location of the reinforcing steel by using a metal detector.

Divers' Intercommunication Unit.—Assistance was given to the Navy in making a divers' intercommunication unit to allow communication between two divers and the surface position. Arising from this, advice and assistance is being given to the Navy in the establishment of a diving school.

Hayssen Carton Wrapping Machine.—A photo-electric cell unit and associated amplifier was constructed to detect registration marks on printed over-wraps. (See under Design Section.)

School for the Deaf, Kelston.—As many technical aids are now available to assist in the education of the deaf child, a comprehensive survey was undertaken of overseas practices and instruments in use. A design of a suite of rooms considered suitable for the installation of equipment for tuition of the children was prepared. General recommendations regarding the sound treatment and layout of the remaining classrooms were made. This work has been carried out in co-operation with the Health and Education Departments.

Group Hearing Tests.—Assistance to Health Department officers was given in the group hearing evaluation of children at normal schools to determine the number of children requiring special treatment or admission to a school for the deaf.

Checking Fire Holes in Small-arms Ammunition.—It is necessary to examine each cartridge case to see that the fire holes are clear, and this has previously been done visually. A sensitive photo-electric unit and amplifier has been designed to do this work. It can detect the presence of partially as well as completely blocked holes. The unit is incorporated in a spare station of the White automatic case-gauging machine.

Speed Fluctuation on Board-forming Machine.—The voltage output from two tachometers driven from two individual shafts in different parts of a board-forming machine was arranged in a bucking circuit with a centre zero indicator to read the differential voltage. Fine synchronization of speed of the two sections of the machine are possible by this means.

METALLURGICAL SECTION

Much greater use has been made of the mechanical testing facilities available during this year. Mechanical testing of concrete roofing tiles to standard specifications has proved of great assistance to local manufacturers. The machines of this section are also used by the New Zealand Forest Service, the State Hydro-electric Department, and the Ministry of Works. The testing of all material used in welding, including welding electrodes, and the approval of individual welders are carried out for the Ministry of Works.

Over the past year a number of chassis and steering assemblies have been examined on behalf of the Transport Board. Some transport companies are also using these facilities in the routine inspections of their vehicles. This has detected a large number of incipient defects in steering assemblies.

The consultative work of this section is increasing rapidly, particularly in the foundry industry. More manufacturers are having tests and inspection of materials prior to processing, particularly when material is purchased from unidentified sources handled by Continental firms.

The trade tests for welders of the R.N.Z.A.F. and Tasman Empire Airways, Ltd., involves preparation of specimens to British civil airworthiness requirements. During the year all these specimens were examined and tested at A.I.D.L. This involves some fifty candidates, and the work will probably continue at this rate.

In response to industry's demands, the Section intends to provide gamma ray inspection facilities for the testing of welds and castings.

WORKSHOP SECTION

In addition to the large part that the precision workshop has played in the development work, it has undertaken a number of special constructional jobs. Some of these are a compressometer, modified from a Dominion Physical Laboratory design, for timber testing by the New Zealand Forest Service; and assistance to Dominion Physical Laboratory in making two geothermographs and some rock-testing equipment.

Equipment has been made for several soil mechanics laboratories, including two consolidation machines—one for the Auckland City Council and one for the Ministry of Works. A liquid limit apparatus was made for a private contractor. Modifications were made to liquid limit apparatus held by several soil laboratories to bring these into line with the latest British standard specification.

An intricate embossing die for printing on card in colours was made of the Royal Army Service Corps badge. Several instruments for educational purposes were undertaken, including a torsion meter for Seddon Memorial Technical College. Considerable instrumental and development work was executed for the Underwater Research Laboratory.

GENERAL

British Medical Association Conference 1953.—These Laboratories were represented at this conference, and a number of the instruments developed by the Laboratories were demonstrated. Considerable interest was shown by visiting medical people.

Industrial Exhibition at Auckland Birthday Carnival, 1953.—These Laboratories had an exhibition stand in the " Hall of Progress ". Its theme was mainly industrial, but the work of the Medical Instrumentation Group was also shown. Considerable interest was shown by all sections of the public in the exhibit.

Visit of Dr William Blum.—Dr Blum, the eminent American authority on electroplating, presented an illustrated lecture dealing with the chemical and research aspects of electroplating and electro-forming.

Colombo Plan Students.—During the year a number of Pakistan and Indian students have spent some time with staff of the Laboratories to study the manner in which they assist industry. They were also conducted round selected industries.

Survey.—The Department of Industries and Commerce was assisted with an engineering survey of local industry.

Visitors.—During the year members of the Chamber of Commerce paid a visit to the Laboratories.

PUBLICATIONS

Three reports written by members of the staff were published.

BOTANY DIVISION

Director: Mr C. M. Smith

ACCOMMODATION

Accessions to the herbarium have gone on steadily, but the available space has not been increased. A change of premises will give much needed additional space, and negotiations have been in train for several months past for the lease

of suitable and more spacious premises in Christchurch. The herbarium should have first place in claims for expansion and improvement in layout, but the ever-growing library must share in the increased room.

EXPERIMENTAL AND FIELD WORK

Agropyron *Studies.*—Work on this genus, which has been referred to in many past reports, has gone steadily on. Although much of the work appears to be obscure and of little applicability except to the botanist, this is not a condemnation. The cytologist points out in his annual report that examination of Australian as well as local species has at last filled the gap in a polyploid series of species and now opens up the possibility of artificial species synthesis by the combined use of crossing and colchicine techniques. Many years of work are thus at last showing promise of future applicability; and the experience gained with *Agropyron* will certainly shorten the period of such preliminary work if it proves desirable to attempt similar analysis of any other native grass genus.

Other Tussock Grassland Work.—The bulletin recorded in last year's report as in press in 1951 is still not printed.

The work at Molesworth has continued, thanks to the assistance of the Lands and Survey Department. Altogether the visits to that station occupied twenty-one man-weeks during the year. The trial nursery was kept in order, and the periodic observations and records were maintained.

There are now permanent quadrats that have had vegetation on them carefully recorded for nine years past. The changes that are taking place under complete protection, but no other interference, are very slow indeed. It can be claimed that improvement is occurring rather than deterioration, but it is not spectacular improvement. This year *Agropyron scabrum* seedlings have been recorded on some plots as unusually abundant, and seedlings of the tussock *Festuca nova-zelandiae* have for the first time been found in numbers, where previously they have been seen only very rarely. Even this hopeful evidence must, however, be interpreted cautiously, since the season has been unusually wet; and the numerous seedlings may be only a seasonal result instead of the desired more permanent effect of protection.

PHORMIUM AND YELLOW LEAF DISEASE

The work that has been recorded for years as in progress was brought to a culmination this year by the publication of a series of papers describing the findings of different workers during their work on the problem. These papers were published together in a supplement issue of the *New Zealand Journal of Science and Technology.*

PALYNOLOGY

The routine slide exposures, examinations, and analyses, were continued. Two papers describing results were published in the *New Zealand Journal of Science and Technology.* Peat and honey examinations were continued as demand occurred. The manuscript of a projected *Handbook of the Fern Spores of New Zealand Ferns* was completed, and it is hoped that publication will be found possible during the incoming year.

SEEDS OF NATIVE PLANTS

The publication of an Index Seminum for regular international exchange was carried a stage further. The cyclostyled lists of two previous years were superseded by a printed booklet of a standard form, with a much increased content. The overseas response was gratifying, and some 1,200 seed parcels were distributed to meet the requests made. This is a recognized service

conducted between the leading botanical institutions of world standing, and both Index and seeds are available for strictly scientific purposes only. This is not always understood by local organizations, which on occasions seek from the Division seed on a commercial scale simply because a species is shown in the Index as available. To comply with such requests would be impossible without the establishment of a collecting, cleaning, storage, and despatch section of unjustifiable magnitude. As it is, the collection and preparation of authentic small sample stocks of fresh seed of some 300 species of plants which often grow only in remote situations is a task that taxes the existing staff and the Division's financial resources. The policy is that every effort will be made to extend and increase the service on the strictly scientific basis (much new knowledge of the habits of native plants has accrued from the work done during the past three years), but that attempts to divert the efforts to large-scale collections of seeds of economic plants only must be resisted unless an alteration is made in policy, with the necessary provision of staff and finance.

MISCELLANEOUS

The Division dealt with several thousand inquiries, and assistance was afforded on botanical matters to many organizations.

The new Gardens Area at Bryndwr, in Christchurch, has been improved, and all the *Agropyron* and cytogenetical work has been established there.

CROP RESEARCH DIVISION

Director: Dr E. J. Godley

The main change in policy at the Crop Research Division during 1952–53 was to strengthen the staff at the Otara Vegetable Research Station (near Auckland) with a view to making this the main centre of vegetable breeding. The Vegetable Section at Lincoln will continue testing for the South Island conditions, and will also be mainly responsible for pure-seed production. Pure seed implies a certification scheme, but this does not yet exist; nor is there yet the organization for widespread testing of varieties such as exists so successfully for other crops (in co-operation with the Extension Division of the Department of Agriculture). With the extension of vegetable breeding, these certification and testing services will soon become necessary, and the situation is being explored.

The abnormal spring and summer rainfall this season has emphasized weaknesses in some well-established varieties. Cross 7 wheat did not cope well with these conditions: its yield in many districts was drastically reduced because of leaf and root infecting fungi, and a probable weakening of root development. The linseed variety, Golden Viking, became heavily infected with pasmo disease.

FIELD CROPS

Wheat.—One line of wheat has yielded considerably more than the standard variety Cross 7 in the extensive trials of four years carried out with the co-operation of the Extension Division of the Department of Agriculture. Unfortunately, this line is inferior to Cross 7 in baking quality. Two other promising lines that have not been tested so extensively will be sown again in the coming season. Of these three lines, one should be released for growing commercially within the next two years.

Another project is to breed a high-yielding wheat with stiff straw and tight chaff for high-fertility land where Dreadnought is grown. This work has begun on a small scale in the Waimate district with the co-operation of the Department of Agriculture. Several lines have been selected for testing during next season.

Disease Resistance of Wheat.—The breeding of wheat resistant to mildew is being continued, and the first resistant material is ready for field tests.

Oats: Resistance to Lodging.—Seed of oat varieties was received from Aberystwyth several years ago. One of these proved successful in Extension Division trials. It is high yielding, short strawed, resistant to lodging, and is suitable for combine harvesting. Arrangements have been made for the commercial milling of the produce of a block of 3 acres. If it is acceptable to millers, this variety will be released under its English name "Milford".

Several lines that combine high yields with resistance to lodging have been selected for further tests.

Disease Resistance of Oats.—The varieties formerly used as resistant parents in the breeding of lines resistant to crown-rust are no longer resistant to the races present in New Zealand. Further resistant parents have been obtained, and the work of breeding agronomically suitable lines is being continued.

Barley.—The field trials of Danish barleys have been continued. The produce is used by the Department of Agriculture in variety trials in the main barley-growing areas. Small-scale tests have been continued with overseas varieties as they become available.

Rye-corn.—The use of the polycross method of breeding has resulted in visible improvement in a strain of N.I.A.B. rye-corn.

Potatoes.—Losses from diseases are estimated to be of the order of 20 to 25 per cent of the crop each year, or a value of £200,000 to £400,000. In the Auckland district, potato blight could wipe out all the present susceptible varieties if they were not sprayed at least weekly, and the loss would be some £40,000 to £50,000 per annum.

Potato Viruses.—A survey of the virus-free stocks being increased by the Department of Agriculture has shown that all five varieties are still free from X, Y, and leaf-roll viruses. These stocks will now go under trial for one season before release to growers for replacement of existing diseased stocks. Breeding for immunity to viruses X and Y has been proceeding slowly, since it would appear that the factors for immunity to the Australian strains of these viruses, which are present in the parental hybrids, do not give complete immunity to New Zealand strains. However, a few of the progeny of crosses with the Australian hybrids appear to be immune and will be used for subsequent crossing.

A field study of the natural spread of leaf-roll and virus Y has shown that leaf-roll spreads very slowly at Lincoln, but virus Y relatively fast. This accounts for the very slow deterioration in the variety Aucklander Short Top, which is fully infected with the viruses X and Y. In fact, seed grown and unselected at Lincoln for four seasons gave a higher yield than a new stock of "Mother" seed (highest grade of certified seed), and this suggests that care of the seed potatoes was of more importance than the spread of leaf-roll, which increased from 0·5 per cent to only 1·9 per cent over four seasons.

Potato Blight.—The set of differential varieties obtained from Dr W. Black, of the Scottish Society for Research in Plant Breeding, has been used in studies on the blight strain from Pukekohe which attacked previously immune varieties. The strain has now been identified as equivalent to Dr Black's strain "B". Two further strains have been found: one (possibly strain "C") on a hybrid immune from strains ABDEF and one on a hybrid immune from strains ABCD. These two strains have not yet been positively identified, but at least some breeding material is resistant to both. The results to date suggest that the normal A strain can produce new types which survive when plants immune from A are grown, but otherwise are swamped out in competition with the more vigorous A strain. Consequently, it is expected that many other strains will be

found as breeding progresses, and to assist breeding projects it may be advisable to short-cut the process and import known strains from overseas.

Rape.—Of five lines from the cross Club-root Resistant by Broad Leaf Essex, two lines approach B.L.E. in earliness and yield. Further resistant selections have been made from the second generation of this cross. Work on aphis resistance continues, but aphids have not been at all numerous in the fields this year.

Swedes.—The first generation of crosses between a club-root resistant and susceptible varieties has proved to be resistant. Second and back-cross generations are now under test. A heavy infection with club-root has been induced on about 1 acre at Lincoln, and this will facilitate testing, which is at present done in Invermay.

Plants from Wilhelmsburger Otofte, apparently resistant to dry-rot, are being progeny tested.

Some of the varieties that were shown to have high aphid resistance last year have been differentiated this year by their reaction to the two common aphid species. While Calder is resistant to *Brevicoryne brassicae,* it is as susceptible to *Myzus persicae* as Superlative. Wilhelmsburger Otofte, on the other hand, is as resistant to *B. brassicae* as Calder, and has a degree of resistance to *M. persicae.*

Kales.—Crosses between strains of leafy chou moelliers give some indication of hybrid vigour. The possibilities of using this on a commercial scale are being investigated.

Peas.—Breeding and selection of wilt-resistant field and garden peas is being carried on. Two generations have been completed this year. Greenfeast wilt-resistant selections have had one field trial for yield and type, and selection was made in this trial for maturity. Four lines conforming to the Greenfeast standard have been sent to England for testing.

In the other varieties, Onward, William Massey, Blue Prussian, and Partridge, all material was grown in a naturally wilt-infested area. Several promising selections resulted.

Further tests on selections from the cross (Greenfeast × Greatcrop) × William Massey have been made by the Marketing Department, Pukekohe, for suitability for canning, while further seed yield trials have been conducted at Lincoln.

Selections made for pure-seed production of Partridge have been increased for handing over to Department of Agriculture. A similar scheme for Blue Prussian is being carried out.

Lucerne.—The grazing trial of *M. glutinosa,* Grimm, and N.Z. Pedigree Lucerne, is now established. Collection of data from this trial should begin in the 1953–54 season.

The polycross test of 42 *M. glutinosa* selections has yielded a small quantity of seed for test.

The collection of lucerne varieties and species has now been planted at Cass, Craigieburn, Omarama, Rotorua, and Lincoln.

Linen Flax: Rust Resistance.—The back-crossing projects to make Liral Crown and Concurrent resistant to all known races of rust are at their fifth back-cross and are progressing well at a rate of three generations a year.

Selection work for complete rust resistance has been started on the F_2 material of the following crosses: D.83 (RII) × Tammes Pale Blue and 806/3 (RIII) × Tammes Pale Blue, 1,350 selections being made.

From European countries and from Africa, Russia, Afghanistan, and Turkey, 40 varieties have been tested with races 1 to 12, to which all linen flax varieties were susceptible until now. Two varieties—1288/12 Russia and Turkish Ech 121—showed a high percentage of immune plants.

The aim is to have a greater diversity of genes in breeding for rust resistance to reduce the risk of all varieties breaking down at one time. Studies in the genetics of rust resistance are being continued.

Linen Flax: Lodging Resistance.—A new project has been started to discover varieties more resistant to lodging than the present varieties grown. Twenty-four varieties have been introduced for this purpose, and replicated field trials have been made at Geraldine and Winton to test varieties for lodging resistance, yield, and fibre quality. Two varieties, Hollandia and Percello, seem to be promising in this respect.

Linseed.—The complete breakdown of Golden Viking to pasmo this season has diminished the value of the project designed to confer rust resistance on this variety. The genetic basis of pasmo tolerance is being studied.

Two new rust races have been isolated: Race 13 attacking the hitherto immune selections Koto 5 and 25, and Race 14 attacking Redwood selections and others. All these selections, however, have a high field resistance. Koto 25 is a promising selection, for it has yielded higher than Koto or Koto 5 in trials this season, and ripens earlier. Koto 5, 25, and Rocket have been handed over to a commercial firm for further multiplication.

Blue Lupin (L. angustifolius).—The breeding project to combine the rapid early development of Bitter Pink lupins and the low alkaloid content of New Zealand Sweet White is still in progress, though it will be difficult to surpass the sweet Borre lupin. Borre was again definitely superior to other sweet varieties in seed yield, plant establishment, and early maturity. Seed is now being increased.

Trials have indicated the advantages of sowing a mixture of rape and lupins. Borre has proved a good variety for such a mixture, as it matures at about the same time as rape and competes successfully. Trials of rape, Borre, and their mixture, are planned throughout Canterbury.

Development and Seed-setting in Lupins.—The high cost of seed is often a deterrent to the use of lupins as a fodder crop. Usually no more than half the flowers on a plant set seed, and the cause of this is being investigated in yellow lupins. The effect of day length on development is being surveyed by sowing Bitter Pink and Blue lupins every fortnight during the year. A faster development to flowering in later sown material, particularly after October, shows that selection for early development should be made on late spring or autumn sown material.

VEGETABLES

Savoy Cabbage.—Uniform and higher quality lines are being produced by inbreeding and selection. Nucleus seed of one such early strain has been handed over to the Horticulture Division of the Department of Agriculture for seed increase.

Carrots.—Selection work has continued within the variety Holmes Improved with the object of obtaining a smaller, stump-rooted type of carrot suitable for market garden and home garden use, the original type being a cattle carrot. Some considerable improvement has been obtained over several years of selection, especially in the colour and texture.

A pulling trial was carried out to find out whether the Lincoln-selected type of Holmes Improved develops sufficiently rapidly to be used as an early pulling carrot as well as a maincrop carrot. Comparisons were made in a replicated trial with ordinary commercial varieties such as Chantenay and Manchester Table, and the results show that the Lincoln selection of Holmes Improved gave a significantly higher yield than the other varieties, both as an early maturing and maincrop carrot.

Tomatoes.—Twenty-five crosses were made in an attempt to combine high yield with early maturity. The cross and parents are being grown together to detect any hybrid vigour.

Dehydration of Vegetables.—Four varieties of cabbage and two varieties of carrot were grown for dehydration tests in collaboration with the Chemical Engineering Section of the Dominion Laboratory.

AGRONOMY SECTION

Full exchange of views between this Division and the farming industry, the agricultural extension services, and the colleges, is essential to the continued well-being of the Division. Established channels for collaboration have been further strengthened by visits to farming districts and attendance at farming conferences.

A review of the present and potential usefulness of linseed and sweet lupins has been undertaken. Linseed is a useful addition to cash crops, whereas the wider use of present sweet-lupin varieties is unlikely. This review has aided decisions on future lupin and linseed breeding work.

A map of Canterbury's natural cropping regions, based on soil type and other physical factors, is being prepared. When completed, a systematic study of crop ecology will be possible.

Agronomic research has centred on cereal greenfeed and lamb-fattening crops. Investigations into the techniques for measuring effective yield have been continued. Yield increases by means of sowing legume and non-legume forages together have been investigated. The addition of Broad Red clover to Wong barley summer-sown for greenfeed, and of Borre Sweet Blue Lupin to B.L.E. rape, both resulted in substantial yield increases. These combinations will be further tried in several districts.

In an endeavour to add to the present range of annual crop legumes, a wide range of these is being collected from several countries, through the Commonwealth Bureau of Pastures and Field Crops.

PUBLICATIONS

Eleven papers have been published by staff members during the year.

DOMINION LABORATORY

Director: Mr F. J. T. Grigg

The Dominion Laboratory is responsible for most of the chemical and chemical-engineering activities of the Department, including research work and service work for Government Departments.

On the research side its functions relate mainly to the investigation and development of the natural resources and products of New Zealand such as wood products, building materials, mineral resources, meat for export, dehydrated meat and vegetables for defence needs, thermal waters and gases, and a variety of other projects.

On the service side the Laboratory is consulted by almost all Government Departments, and carries out a wide range of analyses, some of the largest demands being from Departments such as Health, Works, Police, Highways Board, and State Advances Corporation. In addition, its services are sought by local bodies such as Hospital Boards, Education Boards, municipal Councils, etc.

It is also called upon to assist the secondary industries, and while an analytical service for industry cannot be offered such as would be supplied by a consultant, work, where possible, is undertaken if the necessary service is not

otherwise available. An example of aid to industry is the work on curing being carried out for the bacon-curing industry with the immediate object of eliminating the use of boric acid, a chemist being allocated full time to this work.

Following the transfer last year of the Chemical Engineering Section to Gracefield Road, Lower Hutt, new laboratory accommodation has this year been provided in the same building for the sections dealing with coal research and isotope investigations. This additional space helps to relieve congestion in Wellington, but there is urgent need for a new building to house all sections of the Laboratory.

Under the Colombo Plan a chemist from Pakistan (Mr I. H. Chaudri) spent a considerable portion of the year studying metallurgy at the Laboratory.

A table on page 39 gives the numbers and sources of samples received for analysis.

BUILDING RESEARCH

The preliminary results of the pozzolana research have been incorporated in a report. The early conclusions have been confirmed by larger-scale concrete tests at the Dominion Physical Laboratory. The possibility of the use in concrete for hydro-electric dams of diatomite from Whirinaki valley, where there are large deposits, is being investigated. Experiments on the wet storage of ground pozzolanas showed that, at a suitable water content of the suspension, storage under laboratory conditions was feasible. Concrete drainage pipes made with ground pumicite as pozzolana are under test for sulphate resistance.

In addition to many analyses of cement used in hydro-electric dams, work was done to determine the heat of hydration of Milburn cement at various periods after setting. If time can be found for it, similar work will be done on other cements used in dams.

The resistance of concrete to sulphate solutions, which is largely dependent on the type of cement used, was studied, on which a technique recently developed at the National Bureau of Standards, Washington, was used. Preliminary tests showed that Golden Bay low-alkali cement (a high-iron type) has a low susceptibility to sulphate attack. This suggests that it might be specially useful for concrete sewer pipes and for resistance to sea water.

Aggregates to be used in concrete for harbour works at Tauranga were tested by the Mielencz chemical test for harmful reactivity with cement, and a suitable aggregate was selected on this basis.

Following the visit of a senior officer to the United States, the use of expanded perlite in plasters and as a light-weight aggregate in concrete was suggested. Samples of what appears to be similar material were collected in New Zealand by the Geological Survey, and will be tested as soon as a suitable furnace is constructed.

Some preliminary work was done on the production of gas concrete of the "Ytong" and "Siporex" type, as used in Sweden for light-weight concrete construction, but further work has been deferred.

In collaboration with an officer of the Geological Survey, two public buildings where deterioration of stone was evident were inspected, and remedies were suggested.

Many samples of timber preservatives and of preservatized timber were examined in the Auckland district laboratory, mainly for the Plant Diseases Division, and information was prepared for the committee of inquiry into the use of boric acid as a timber preservative. The Auckland laboratory also made investigations on the failure of penetration of creosotes at the Waipa mill.

With the object of finding the most soluble combination of borates in water for the impregnation of timber, the solubilities of various borates were investigated.

In an attempt to ensure the use of better materials in the painting of State houses, the Housing Division of the Ministry of Works greatly intensified the sampling of exterior oil paints used by contractors. The number of samples examined from all sources was about the same as the previous year, and included 420 samples of exterior house paints and 81 other samples, which included coal-tar paints, traffic paints, linseed oil, putties, and miscellaneous paint materials.

Accelerated weathering tests in the " weatherometer " were made on 188 painted test panels.

Corrosion tests on 27 painted metal test panels were made.

About 100 samples of branded fleece wool were exposed in the " weatherometer " for determination of the resistance of the branding to exposure.

Light-fastness tests were carried out on coloured plastic telephone mouldings, on coloured printing for the Government Printing Office, and on photographic mounting adhesives, the latter to determine the cause of discoloration of mounted prints.

Durability tests were made on a series of proprietary paints to be used in painting wired glass for the exterior sheathing of a power house.

Tests were carried out on factory-produced batches of varnish used for sealing bullets into cartridge cases.

Control testing was done on the application of coal-tar enamels to the pipes for the new Wellington water supply.

To enable Departments to prepare lists of approved enamels, a confidential report on the examination of a complete range of proprietary interior enamels is being prepared. A standard specification for enamels is being drafted for the Government Purchasing Standards Committee. To enable an accelerated test to be included, an attempt is being made to correlate gloss retention of enamels exposed to a carbon-arc lamp with retention under normal interior exposure.

A standard specification for paints for use on carriages and freezer wagons was drafted for the New Zealand Railways.

Inspections were made of the five paint-test fences, and the results are being subjected to statistical treatment.

To determine the cause of difficulties in the application of imported coal-tar paints to dam gates and penstocks, an inspection of the painting at Maraetai was made and advice given. To avoid damage to the surfaces of screens painted with coal-tar paint through rubbing while being lowered into positon on the face of the dam, suitable lubricants were recommended.

" Weatherometer " tests were commenced on the various modifications of the " PWD No. 2 " standard red-lead priming paint.

Further work was done on the causes of the blackening of exterior oil paints. Outdoor exposure tests showed that blackening is confined to paints containing white lead. A leadless paint containing zinc oxide, titanium dioxide, and extenders has not shown discoloration during an exposure of eighteen months. No support has been obtained for the theory that the blackening is due to mould. Various fungicides added to a lead-zinc test paint did not protect it from blackening.

Service trials of putties made from New Zealand and English whitings were commenced.

ROCKS AND MINERALS

A sample from the Buller River was found to be rich in fluorspar and barytes, and it is suggested that the locality should be further prospected.

Several samples of high-grade manganese ore from Fiji and the Cook Islands were examined. There is a possibility that battery-grade manganese dioxide could be obtained from those sources.

Owing to the shortage of sulphur for the manufacture of sulphuric acid and superphosphate, many samples of pyrites collected by the Geological Survey were analysed for sulphur content.

Many other rocks, minerals, and ores were analysed for the Geological Survey, and assays were made for gold, silver, lead, zinc, and copper.

With the aim of speeding up rock analysis while maintaining the required accuracy, research was carried out on volumetric and photometric methods of analysis. The flame photometer was used regularly for the determination of sodium and potassium. The new methods are very promising, and the results will be published.

ISOTOPES, RADIOACTIVE AND STABLE

Space is available at Lower Hutt for the chemical preparation of samples for the mass spectrometer and for the purification of carbon for the measurement of the age of specimens. Radioactive isotopes of high activity must still be handled in the unsuitable accommodation in Wellington.

Age measurements by radioactive carbon (C^{14}) were delayed because of contamination of the samples by radioactive impurities, including radon, but useful results are now being obtained.

Assistance was given to the medical staff at the Wellington and Palmerston North hospitals in the treatment of blood cancer with radioactive phosphorus (P^{32}). Ten cases were treated.

Towards the end of the year the mass spectrometer at the Dominion Physical Laboratory became available for the measurement of isotopes. New techniques were developed by the Dominion Laboratory for the preparation of gaseous samples for this instrument. Preliminary measurements were made on the hydrogen isotopes in New Zealand glacier waters. In co-operation with the Fruit Research Station, research, using radioactive nitrogen (N^{15}), was commenced on apple-tree metabolism.

Several questions on the possible use of radioactive isotopes in industrial problems were handled. They included the use of isotopes in the control of timber preservation, in the control of the disposal of effluents from a proposed pulp and paper mill, and in cement manufacture.

RESEARCH ON HEAVY WATER

In connection with the suggested production of heavy water from geothermal steam, consideration was given to the factors that might influence production in various localities. Investigation of the corrosiveness and scale-forming properties of the steam was commenced at one bore.

MEAT RESEARCH

A pilot plant with a capacity of 50 lb. was built to dehydrate meat in liquid fat under reduced pressure. It operated satisfactorily, and produced several batches, which compared very favourably with those prepared in the laboratory-scale apparatus. The product is being used in tests for palatability and keeping quality.

An officer of the Laboratory continued to study muscle proteins at Cambridge, England.

Further work was done on rigor mortis in beef muscle. The changes in hydrogen-ion concentration and in content of adenosine triphosphate during the

onset of rigor mortis were studied. This work should throw light on the requirements for best results in meat works.

Some bacteriological work was done on the organisms responsible for "bone taint".

Work on connective tissue was commenced by an officer of the Defence Scientific Corps seconded to the Laboratory.

A further investigation was made of the conditions of transport of meat from freezing works in Hawke's Bay to ships at Wellington. The insulated trucks used in these trials were unable to maintain the meat at a sufficiently low temperature.

Chemical and bacteriological services were provided for those responsible for sending an experimental shipment of chilled beef to England. Frozen and quick-frozen carcasses were included in the shipment. On arrival at England, all classes of carcasses were in excellent order, and reports on quality and palatability were most favourable.

Research on bacon curing was continued in collaboration with the bacon industry, principally in the development of a method for curing bacon without the use of boric acid. It has now been shown that when using the recommended process the nitrite and nitrate contents of the bacon can be kept well below the Health Department limits. A test has been organized to determine whether the experimental bacon will withstand the transport and storage necessary for its retail distribution in the warmer districts of New Zealand.

WOOD CHEMISTRY RESEARCH

The investigations of the properties of the cellulose and hemi-celluloses of *Pinus radiata* were continued.

Examination was commenced of the heartwood extractives of Douglas fir, European larch, and *Pinus* species grown in New Zealand. As these extractives determine to a large extent the durability of the timber, it should be possible from a survey of the quantity and nature of the extractives present to classify the timbers for durability.

THE SPONTANEOUS IGNITION OF WOOL

The practical problem of preventing fires in wool carried in ships appears to have been solved, and no such fires occurred during the year. Research is now directed towards discovering the cause of spontaneous ignition and isolating the chemical compounds responsible. It was established that fires were peculiar to "pie" wools, and did not take place in the absence of body fat. Fat extracted from pie wools was separated into five fractions by differential solubility in light petroleum and 80-per-cent aqueous alcohol. The firing tendency of pie wools appears to be related to the amount present of one of these fractions, and its composition is being investigated.

GEOTHERMAL STEAM

Sampling and analysis of water and steam from the bores at Wairakei was continued. The purpose of this is, firstly, to obtain fundamental scientific information to aid in determining the structure of the subsurface and the origin of the steam, and, secondly, to obtain immediately useful information on the corrosive action of the steam and water on metals and other constructional materials. Related to this is the measurement of the relative amounts of steam, liquid water, and gases such as carbon dioxide and sulphuretted hydrogen emitted from the bores.

OIL, BITUMEN, AND TAR

Oils analysed included lubricating oils, mainly for the Government Stores Board, aircraft fuels for the Air Department, fuel oils for the Customs Department, and miscellaneous related products from various sources. Six grades of mine-car greases from two tenderers were examined for the Stores Board. The greases were very variable in characteristics, and in some instances were not true to label.

To supplement the test engine that has been used for many years for testing the knock rating (octane number) of motor fuels, a second more elaborate and supercharged engine was installed by the Laboratory staff for testing the knock rating of aircraft fuels under rich-mixture conditions such as occur during aircraft take-off.

The losses of light fractions in the distillation of New Zealand crude oil at New Plymouth were investigated for New Zealand Oil Refineries Ltd. The recovery of higher yields of motor spirit would require more elaborate and expensive distillation equipment at the works.

After loss of an aircraft off the coast, a supposed oil slick was investigated. About 8 mg. of oil was recovered from about a gallon of sea water. The fluorescence of the oil under ultra-violet radiation and its other characteristics were consistent with those of an aircraft-engine oil.

Work on road materials was carried out mainly for the Main Highways Board. As supplies of bituminous materials are still short, shipments are being received from a variety of sources. Arrangements were therefore made to ensure that as far as possible every shipment was checked. As sealing materials now have to be blended locally, the Laboratory is responsible for advising on the compounding of the blends. The number of samples analysed increased to 130 (from 107 in 1951).

Samples of tar products were received from New Zealand gasworks in connection with their utilization for roadmaking purposes.

PHYSICAL CHEMISTRY

Physical methods were extensively used throughout the Laboratory as adjuncts to chemical methods. Special physico-chemical methods, such as spectrography and X-ray crystallography, were applied in investigations of many kinds, and particularly in corrosion problems.

Faulty nickel plating of articles supplied to a Government Department was shown to be due to a change to barrel plating, resulting in a thinner coating of nickel.

A method of reconditioning Army radio valves damaged by fungus was suggested.

A coin suspected by the Reserve Bank to be counterfeit was shown to be genuine. The constitution of the alloy had been altered, apparently by the action of heat.

An investigation was made of the carbon granules contained in faulty telephone transmitters.

Government records damaged by fire and water were examined to determine whether they were liable to fire spontaneously. Assistance was given in devising methods of drying the many tons of paper before mould attack could occur.

The possibility of spontaneous combustion in copra during storage was investigated. Although considerable heating could take place, the risks of firing were slight.

To assist in the production of salt from sea water, measurements were made of the vapour pressures of sea water at various concentrations up to and beyond the crystallization point of sodium chloride.

Many inquiries on physico-chemical problems were answered, and faults in physico-chemical instruments rectified.

METALS AND CORROSION

Analyses were made of metals and alloys to check compliance with purchasing specifications and to evaluate corrosion resistance, mechanical properties, weldability, castability, and strength at high temperatures. Many industrial inquiries on the uses of metals were answered, and spectrographic analyses were made to identify types of alloys used. Instances of corrosion were investigated, and advice was given on suitable metals to resist corrosion.

Severe corrosion of a tractor engine was found to be due to calcium chloride in a commercial anti-freeze compound.

Corrosion of an aluminium asdic dome was due to galvanic action from use of a conducting gasket material.

Advice was given on the choice of a pipe for taking skim milk to piggeries, to avoid zinc poisoning from galvanized iron.

Corrosion-resistant alloys were recommended for power-house intakes and penstock expansion joints.

An estimate of the comparative life to be expected from copper and galvanized-iron spoutings for State houses was prepared.

Tests of roofing materials for locomotive sheds were continued.

Further work was done on the corrosion on aircraft used in aerial top-dressing. Structural materials, such as metals, fabrics, and glued wood, were subjected to a dew-deposition cycle whilst contaminated with superphosphate, phosphorized pollard, and other agricultural materials likely to be spread by aircraft.

Attention was given to the problem of selecting corrosion-resistant materials for use in the development of power from geothermal steam. A survey was first made of corrosion in the equipment in use at Wairakei. To discover the effects of wet steam and aerated wet steam on plant such as turbine blading, casings, and steam valves, a six-month test was carried out with metal specimens of different kinds exposed in a stressed and in an unstressed condition.

CHEMICAL ENGINEERING

A survey of the citrus industry was made to determine in what directions chemical-engineering assistance would be useful.

Samples of dehydrated cabbage and carrot were prepared (from vegetables grown in New Zealand from English seed) and of dehydrated King Edward potatoes. These were tested for quality and sent to England for further testing.

A wet process for the purification of coal gas was investigated on a pilot plant built at the works of the Wellington Gas Co. It was found that the process worked smoothly only if hydrogen cyanide was first removed from the gas. A simple scrubber for this purpose was developed. The process promises to be cheaper than the iron oxide process at present in common use in New Zealand.

An officer who made visits to plants in England, Holland, France, Germany, and the United States prepared a comprehensive report on the manufacture of phosphate fertilizers by methods that do not require sulphur. Three of these would possibly be cheaper than the superphosphate process, and two are being investigated. An examination of the use of oxalic acid (manufactured from wood waste) to replace sulphuric acid for superphosphate manufacture showed that it could not compete economically.

Using flotation, magnetic separation, spiral washing, and washing with acid, it was found possible, from the felspar deposits at Kaiteriteri, near Nelson, to produce at reasonable cost a first-grade felspar suitable for the manufacture of high-grade pottery.

Although there was no fuel-technology officer in the Wellington Laboratory for the first nine months of the year, an advisory service to industry was maintained by an officer stationed in Dunedin. Six industrial boiler plants were tested, including a detailed investigation of those at a tannery and a cheese factory. The relative costs of firing by coal and by imported oil fuel were carefully examined for four proposed boiler plants. The distribution of overseas fuel information and a departmental fuel-technology news sheet were continued.

In addition to research projects, advice was given on many chemical-engineering problems. These included drying and pulverizing of materials, removal of dust and fumes, concentration of tomato juice, and canning of foods.

COAL

Routine analysis of coal samples continued on a reduced scale.

Drill samples were analyzed in the course of the survey being made to determine the reserves in the Waikato district of coal for the generation of electricity.

Coals from the Paparoa district were analyzed and their coking and swelling properties determined.

Limestone dusts to be used for the suppression of coal-dust explosions in mines were examined.

Air from mines and factories and flue gases were analysed.

AVIATORS' OXYGEN

An intensive investigation was made in the Wellington and Christchurch laboratories on the use of the high-pressure hygrometer and other methods of determining the moisture content of aviators' oxygen.

TOXICOLOGY AND FORENSIC CHEMISTRY

Poisons found in post-mortem specimens included barbiturates, strychnine, cyanide, carbon monoxide, arsenic, nicotine, lysol, cresol, lead, DDT, hexaethyl tetraphosphate, acetyl-salicylic acid, atropine (liniment), quinine, acetic acid, potassium bromate, and "Anthisan."

The Wellington and Auckland laboratories collaborated in a review of data on fatal cases of poisoning by barbiturates in their records. For some barbiturates, tissue concentrations in fatal cases were lower than any in the published literature.

A boy one year old died from a teaspoonful of potassium bromate (bread improver) given in mistake for medicine.

A child aged two years drank an insecticide consisting of a solution of benzene hexachloride and DDT in kerosene. No DDT was detected in the liver or brain, but a breakdown product of DDT was extracted from those organs.

A child was observed to eat paint on several occasions, became ill, and died. No significant amounts of lead were found in the brain, liver, or kidney, but 205 parts per million of lead was found in the bone (femur).

Determinations of alcohol in blood, urine, and stomach contents were made on victims of traffic accidents. Concentrations found ranged up to 0·43 per cent.

In several collision cases scientific assistance was given to the police in matching specimens of paint and glass from vehicles.

Professional help was also given in cases involving liquor, in burglaries, thefts, frauds, forgery, bookmaking, doping of racehorses, and a tram accident.

The new "Lanconide" finger-print powder supplied by the Dunedin laboratory to police officers proved superior to the old mercury and chalk powder.

PESTICIDES

The chemical analysis of pesticides for certification was continued, and involved a great deal of work. The number of new organic substances used in pest control is increasing rapidly, and necessitates much research in developing new and complicated methods of analysis.

Great interest is being taken by health authorities in residues remaining on fruit and vegetables. Apples, pears, and tomatoes were analysed for residues of lead, arsenic, selenium, mercury, DDT, and Parathion.

The work on the selenium content of apples from trees sprayed or watered with selenium-containing sprays was continued.

Cigarettes and confectionery were examined for possible contamination with DDT from leaky containers during transport.

FOOD AND DRUGS

In the districts of the Auckland, Christchurch, and Wellington laboratories sampling of foods and drugs by the Department of Health was appreciably reduced, while the number of samples taken in the Otago District increased.

Some foodstuffs, particularly bread, continued to show evidence of careless handling in the number and variety of filthy and otherwise dangerous foreign materials found to be present. After quoting a lengthy list of such contaminants found in bread, the Auckland analyst commented that, since most of the offending samples were from one bakery, the position relative to foreign matter in food appeared to be improving. In the other centres there was no noticeable improvement on the bad position commented on in previous reports of the Laboratory.

Although numerous breaches of the Food and Drug Regulations were detected, the proportion of adulterated foods on sale was not high. When the number of samples taken is reduced it is found, however, that the quality of foods tends to be lowered.

Meat in its various forms was given particular attention. Of about 300 samples of fresh meat taken, 39 (chiefly from Wellington and Auckland) had been illegally dusted with sulphite preservative. Of about 300 samples of minced meat, 24 contained an excessive amount of sulphite. Of a similar number of sausage and saveloy samples, 21 contained an excess of sulphite. These were almost entirely from Wellington and Auckland. Three samples of sausages and saveloys taken in Otago contained less than the 65 per cent of meat required by the regulation. Eleven samples of bacon out of 45 examined in Wellington contained boric acid, and of these 3 contained more than is permitted (temporarily) by the Department of Health.

Eleven samples of tripe examined in the Auckland laboratory contained residues of boric acid, due to insufficient washing after bleaching with perborate. In other districts the perborate appears to have been replaced by percarbonate, as recommended by the Department of Health, or at least to have been thoroughly washed out.

A few samples of corned beef contained rather excessive amounts of nitrite derived from the pickling process.

Imported canned foods were checked for possible illegal colouring matter and preservatives before being released by the Customs Department.

Traces of poisonous metals derived from tanks, pipes, and other manufacturing plant were sought in beer and soda-water, and in jams and other foods. Lead and copper were found in amounts ranging up to 8 parts per million of lead and 45 parts per million of copper in jam, and smaller amounts were detected in soda-waters.

Iodized salt was checked for iodine content, and a few samples were found deficient.

An improvement was noted in New Zealand egg pulp, which was found previously to be greatly inferior to that imported from Australia owing to its high bacteria content.

An imported canned pearl barley was "faced" with talc to the extent of 2·5 per cent by weight.

All the chlorophyll toothpastes examined were coloured with chlorophyll only.

Butter, except for a few samples containing a slight excess of moisture and a few containing extraneous matter, was generally satisfactory.

Cream samples tended to be low in fat and to have too high a bacteria content.

Milk-shakes and ice-cream, although generally up to the standard in fat, were poor bacteriologically.

In view of the very extensive sampling of drugs carried out the previous year, only a few samples of doubtful products were examined.

Of nearly 4,000 samples of milk examined in the Wellington laboratory's district, 17 were below the standard in fat, 30 contained added water, 2 were stale (as shown by the reductase test), and 9 were insufficiently pasteurized. A further 11 were slightly below the standard in some respect.

In the Auckland metropolitan district the average chemical composition of milk was about the same as in the preceding year. Very few vendors of raw milk now operate in the district. The greatest variation in the chemical quality of milk occurs in samples taken from shops and dairies. As the retail sale of milk other than in bottles is soon to be prohibited, there should be an increase in uniformity of composition.

Owing to bulking, the variations in the composition of Hamilton milk were evened out, and it remained satisfactory.

As noted in previous reports, there were many unadulterated milks which were low in solids other than fat. Freshness, as judged by the reductase test, remained fairly good. The minimum standard set by the regulations is very lenient, and could well be raised.

In Christchurch a further decline in the quality of milk was noted. Most of the milk sold in the city during the four winter months was deficient in solids other than fat. This most unsatisfactory position results from the replacement of cows producing milk of high quality by cows producing a larger quantity of lower-testing milk. The result is that the consumer receives less milk-solids than he should, and the supplier gains financially.

The need for the use of a payment-by-quality formula is urgent in both the Christchurch and Auckland districts.

The milk supplied in the Dunedin metropolitan district showed a general deterioration in quality. There was an increase in the proportion of samples that were stale, watered, low in fat, or low in solids. The efficiency of

pasteurization was maintained. In 880 samples, 43 were low in fat, 59 were low in solids other than fat, and 21 were watered. Of 483 samples subjected to the reductase test, 26 were stale. In the remainder of the district the proportions of samples not complying with the regulations in each of the above respects were about half that found in the city samples.

It had been repeatedly demonstrated in England, America, and Australia, and also at the Dairy Research Institute in Palmerston North, that a short exposure (even half an hour) of milk to sunlight caused a serious loss of ascorbic acid (vitamin C) and riboflavin (a B vitamin) and produced an unpleasant flavour in the milk. By arrangement with the Central Milk Council and the Department of Health, and with the co-operation of interested parties, a series of exposure and tasting tests on Wellington and Hutt Valley milk was made. The results confirmed what was already known about this effect.

For the Department of Health many chemical analyses and bacteriological examinations of water were made, the more important supplies being checked by periodical sampling. Analyses were also made of sewage and of partly purified sewage effluents. Swimming-bath waters were examined bacteriologically and for acidity (pH) and free-chlorine content. Further determinations were made of fluorine in water, particularly from the Auckland district. Water from the districts where there is much scoria tended to contain rather more fluorine than that from other places. Over 1,000 samples of sea water collected by H.M.S. *Lachlan* and other ships were analysed for salinity. To determine the probable resistance of lead-soldered utensils to the action of water, many tests were made of the action of waters on lead. The survey of the pollution of harbour waters in the vicinity of Auckland was continued. The extent of the main sewage fields in Waitemata Harbour and the effects of wind in extending the area of pollution was determined. Boiler feed waters and blow-down waters from boilers were examined as part of the fuel-technology service. Warm spring waters from places in the vicinity of Lyttelton Harbour were analysed.

BACTERIOLOGY

The bacteriological testing of water, milk, ice-cream, milk-shakes, and other foods for the Department of Health was carried out in the four laboratories, although the Wellington laboratory was out of action for the greater part of the year owing to delay in the replacement of a bacteriologist. A considerable proportion of the samples of pasteurized milk, ice-cream, and milk-shakes failed to comply with the standard for absence of coliform organisms. This is, at least partly, due to inefficient washing of bottles, cans, and utensils.

INDUSTRIAL HYGIENE

Owing to increasing demands for chemical work on industrial dusts and fumes, a senior officer was appointed towards the end of the year to organize the Laboratory's work in this subject. Because of staff limitations it was necessary to concentrate at first on the measurement of dust contamination of working atmospheres. As very little of the special apparatus required was available, the arrival of this had to be awaited, and the officer's time was devoted to the making of surveys and the establishing of contacts with the Health and the Labour and Employment Departments.

The work done for many years by the Wellington laboratory and the district laboratories on such matters as lead dust, silicosis, dermatitis, and poisoning by metals, solvents, and gases, was continued. The possible leakage of carbon monoxide into diesel buses was investigated.

SAMPLES

TABLE OF SAMPLES RECEIVED DURING 1952 BY THE DOMINION LABORATORY, WELLINGTON, AND THE DISTRICT LABORATORIES IN AUCKLAND, CHRISTCHURCH, AND DUNEDIN

Contributor or Department	Wellington	Auckland	Christchurch	Dunedin
Agriculture	133	—	64	51
Air	24	2	20	—
Army	22	1	1	—
Customs	119	63	53	80
Education	2	3	—	—
Forest Service	5	250	—	1
Health	5,720	6,803	3,731	3,686
Hydro-electric	177	1	2	—
Industries and Commerce	4	—	2	4
Internal Affairs	8	—	—	—
Island Territories	1	—	—	—
Labour	7	1	—	95
Land and Income Tax	—	—	—	1
Lands and Survey	2	5	—	6
Local bodies	92	10	2,649	144
Main Highways Board	130	—	—	—
Marine	1	533	—	—
Marketing	29	187	217	1
Mines	312	—	—	—
Navy	311	3	2	1
Plunket Society	136	31	18	9
Police	117	240	153	47
Post and Telegraph	63	6	17	3
Pottery and Ceramics Research Association	3	—	—	—
Printer	10	—	6	—
Prisons	178	—	—	—
Railways	29	1	23	14
Scientific and Industrial Research—				
Information Bureau	60	3	—	—
A.I.D.L.	9	—	—	—
Dominion Laboratory	93	—	14	42
Oceanographic Observatory	406	—	—	—
Fruit Research Station	2	—	—	98
Geological Survey	340	—	15	4
Geophysics Division	8	—	—	—
Grasslands Division	—	—	—	1
Dominion Physical Laboratory	52	—	—	—
Plant Diseases Division	427	1,011	—	—
Soil Bureau	26	—	—	—
Industrial	—	—	18	51
Wheat Research Institute	—	—	1	—
Standards Institute	7	—	—	—
State Advances	81	368	3	—
Stores Board	88	—	—	2
Works	759	10	12	51
Miscellaneous	753	—	—	25
Total	10,746	9,532	7,021	4,417
Grand total			31,716	

SERVICE TO INDUSTRY

Owing to reduction of staff it was necessary to scrutinize closely all requests for analytical work from non-Government sources. Where a private consultant was available, the requests were declined. A large number of inquiries on chemical matters were answered by the specialists on the staff of the Laboratory.

The kind of work done for industry is illustrated by the following examples:

Spectrograph examinations were made to identify metals and alloys. Many instances of corrosion of metals were investigated. These included the bearings of a refrigerator compressor, the lead piping of the Wellington City organ, a storage tank for high-octane petrol, and brass-plated zinc slide fasteners.

Analyses were made of lead and zinc ores. Sulphur for use in superphosphate manufacture was analysed. An investigation was carried out to develop a surface for blackboards that should be equal to that manufactured overseas. Many examinations were made of concrete roofing tiles and concrete aggregates. Fibrous and other plasters were investigated. Assistance was given in the use of adhesives required for specially difficult jobs. Work was done on plastics for various uses, including use for water pipes. Specimens of paper and rubber were tested for tensile strength. Moisture was determined in woollen yarns. Accelerated weathering tests were made on 71 panels for paint manufacturers. Humidity-cabinet tests were made on 27 specimens. A powder to be used in the manufacture of fluorescent-lighting tubes was checked for freedom from poisonous beryllium compounds.

GAS TESTING

The gas supplies of the four main centres and of most of the other main towns were regularly examined for calorific value, pressure, and freedom from sulphuretted hydrogen, as required by the Board of Trade Gas Regulations, administered by the Department of Industries and Commerce. During the year testing was commenced at Greymouth and Hokitika in anticipation of these works being brought under the Gas Regulations.

All gas meters put into service were officially tested and stamped before installation at consumers' premises.

PUBLICATIONS

Twelve papers by members of the staff were published in scientific journals.

DOMINION PHYSICAL LABORATORY

Director: Dr A. G. Bogle

The technical divisions of the Laboratory—Standards, Mechanical Engineering, Electrotechnology, Physics, and Building and Civil Engineering Research—have pursued during the year a diverse programme of work falling within the five main functions of the Laboratory. These are the establishment and maintenance of New Zealand's national standards of physical measurement; the application of physics and engineering to the development of New Zealand's natural resources; research related to the country's special needs or its unique geographical position; defence research and development; and specialized assistance to primary and secondary industry and Government Departments.

An organizational development of the year has been the setting up of a separate Mechanical Engineering Development Section charged with responsibility for developments originating outside the Laboratory. This section is attempting in particular to foster contact with the mechanical engineering problems of agriculture. Also, in co-operation with the Grasslands Division, activity has been organized on a small scale to apply the techniques and approach of physics to the problems of plant growth.

In addition to the activities described in detail below, the Laboratory devoted approximately one-sixth of its total effort to defence, mainly in the Electrotechnology and Physics Divisions.

The number of salaried staff of the Laboratory has diminished by 13 to 188.

STANDARDS DIVISION

Progress in the establishment of facilities for the calibration of instruments and sub-standards has been made, and the Division is able to deal effectively with a far greater proportion of requests for this work than formerly. The Temperature and Metrology Sections have had the most significant additions to plant and facilities during the year, and each has handled a heavy load of test work. The Photometry Section, newest in the Division, is receiving an ever-increasing number of inquiries connected with illumination and spectral energy measurements.

Routine calibration work has increased throughout the Division, and it is doubtful if much more can be handled by the existing staff without holding up progress in the establishment of New Zealand principal standard measures.

Some 320 statements of results have been issued for instruments and test samples, apart from limit gauges.

Temperature Standards.—Liquid in glass thermometry is well established in the range 0° c. to 100° c., and the section can meet any local demand in this range. The fixed-point references of the international temperature scale covering the range from the oxygen point (—187° c.) to the gold point (1,063° c.) have been set up and are ready for use when standard interpolating instruments become available. One of these—a specially designed potentiometer, free from internal thermo-electric effects, for precise thermocouple work in the upper part of the range—has arrived and is being installed, but precision resistance measuring equipment, for use with resistance thermometers in the lower part, is still to come to hand.

Work on the measurement of heat evolved by micro-organisms has continued, and there has been activity in a related field—adiabatic calorimetry. This has arisen in connection with the curing of mass concrete. If the mass is not cooled artificially, the heat evolved during setting escapes so slowly that the process is virtually adiabatic. The Concrete Research Section is concerned with the effect of this type of curing on the concrete; the Ministry of Works at Roxburgh requires information on the amount of heat evolved, since this affects the design and the cooling of the dam, and has set up an adiabatic calorimeter, for which this section provided and installed the controls.

The section, which also maintains standards of total radiation, has during the year assisted to record solar radiation at Palmerston North and Lake Grassmere, making calibrated equipment available in each case.

Photometry.—Installation of the Hilger-Mueller monochromator has permitted the transmission characteristics of light filters to be measured in the visible and near ultra-violet regions of the spectrum, and also allows photo electric cells to be calibrated. Various activites have benefited accordingly, among them being the plant growth experiments at Palmerston North and Auckland.

The basic equipment plan has made slow progress during the year, and a large photometric bench and a 3-integrating sphere will be added to its facilities shortly.

Calibration work has been done on a large number of light meters, and tests performed on reflectorizing (traffic) materials and on an aerodrome landing light.

Metrology.—Separate subsections for physical and engineering metrology have been arranged in adjacent rooms, and the basic instruments for the former are being installed as they come to hand. Among these is a hydrostatic balance for general density work. The Pratt and Whitney measuring machine and the 4 in. slip gauge comparator have been reinstalled in their permanent positions. Engineering metrology equipment has been modernized by the

acquisition of a Societe Genevoise AP6 optical projection machine, pitch and internal diameter measuring machines, two precision autocollimators, and an alignment telescope.

The engineering metrology side has received the bulk of the test work of the section and some 160 limit gauges of all sorts have been inspected and certified. Other test work has included the calibration of testing machines, various weighing devices, and small measuring tools.

Comparative density determinations have been done, with an accuracy of one part in a million, on samples of water as one method of assessing the proportion of heavy water present.

Instrumentation.—The section's resources have been used mainly in the service of other laboratory sections, but in addition further development work on instruments for the geothermal project has been done. The "geothermograph" continues to be modified to suit new demands made on it by changing field and underground conditions. Five of these instruments have now been made.

The section has continued to administer the standards of hydrostatic pressure and has calibrated large numbers of precision pressure gauges and allied appliances.

Optical Design.—The section provides the facilities of design, manufacture, test, and repair of optical components, and is of considerable value to laboratory sections. It also provides service and advice to some Government Departments such as Lands and Survey and Army. The officer in charge spent eight months in Britain during the year on leave with pay but otherwise at his own expense. He visited a wide range of establishments dealing with optics design and manufacture, and returned with valuable new ideas on design methods and worth-while projects.

Electrical Standards.—The establishment of voltage and resistance standards completes the establishment of those required for basic electrical measurements. The level of accuracy approximates to that with which their definitions are internationally agreed. The work now in hand is directed towards widening the range of measurements that can be referred to these standards.

The regulations defining the Laboratory as the custodian of the national standards of electrical measurement have been gazetted.

Standards of impedance for alternating currents have begun to arrive from the makers; some progress has been made in setting up the required instruments to use them. A bridge for the measurement of small powers at ultra-high frequencies has been set up. A frequency standard of accuracy sufficient for some years to come has been in operation for some months.

Increasing use is being made by electric supply authorities and industry of the services of the section.

MECHANICAL ENGINEERING DIVISION

Design.—The principal function of this section is to interpret the requirements of laboratory staff in terms suitable for workshop construction. Hence it contributes to a large proportion of the activities described in the various laboratory sections. Two activities of a slightly different sort during the year were the completion of manufacture and test of hardboard samples made in an experimental plant set up to prove the suitability of some New Zealand timbers for hardboard manufacture by the steam-explosion process, and the design for the Soil Bureau of a laboratory pressure membrane apparatus for squeezing water out of soil samples.

Mechanical Engineering Development.—The officer in charge has been appointed the New Zealand Co-ordinator of Instrument Development in an

organization under the Commonwealth Advisory Aeronautical Research Council, and the section is developing two instruments for trial at the Royal Aircraft Establishment.

A small but interesting and important design job was a simple indicator to show the location of leaks in the bed of Lake Waikaremoana. Other design projects have been an experimental seed drill for the Department of Agriculture, a pea-washing machine for a seed merchant, a plotting board for use with the Meteorological Service's wind-finding radar sets, an ultra-high-pressure apparatus for University chemical research, and an experimental hydraulic vibrator.

Metallurgy.—The major activity of the section continues to be the provision of service to industry and Government Departments in carrying out tests and examinations by physical methods and in providing advice on manufacturing and processing methods. During the year, 106 certified reports were issued. An important part of the service work has been the carrying out of radiography at remote or on inaccessible components by gamma rays from radioactive isotopes. The largest user has been the Ministry of Works for problems associated with hydro structures, but work has also been done for the Forest Service and for several industrial firms. The technique has thoroughly demonstrated its value.

The investigation of foundry sands has been completed with the conclusion of tests of the North Island sands from Parengarenga and Herrings' Pit. The survey of foundry practice was carried to the point where conclusions could be drawn and a report written, but was terminated prematurely owing to the cessation of the Industrial Liaison Service. Two other investigational projects were initiated during the year: one arose from fairly widespread difficulties experienced in the remetalling of white-metal engine bearings, and is nearing completion; the other is concerned with the effect of common welding defects on the strength of joints—this is well in hand, and involves tensile, impact, fatigue, and non-destructive tests.

Workshops.—The workshops of the Laboratory continue to provide specialized services to industry and Government Departments in the way of advice on tools and machining processes, manufacture of tools, cutters, jigs, dies, and gauges, for requirements that cannot otherwise be satisfied without the delay and expense of procurement overseas. The demand tends to fall off as New Zealand industry becomes better equipped, but, on the other hand, the effect of recent economies has been to encourage the manufacture in the workshops of laboratory instruments and equipment that would otherwise have been purchased, with the result that workshop capacity has been fully taken up. Industrial jobs have been handled at the rate of about thirty per month, and increased use of the workshop facilities was made by other branches in the manufacture of, for example, meat dehydration plant and fractionating equipment, and by the Hydraulics Laboratory of the Ministry of Works.

ELECTROTECHNOLOGY DIVISION

Applied Radar.—An improved design of microwave vehicle-speed meter has been developed as a result of the intention of the Transport Department to arrange the production of a number of equipments. Performance has been improved and size and complexity reduced; an engineered version has been made which, after approval, will be used as a prototype for production. The application of the instrument to a problem posed by the Royal Aircraft Establishment in Britain—that of measuring the rate of change of height of an aircraft approaching touchdown—appears promising.

Liaison has been established by correspondence with the British Telecommunications Research Establishment, and has resulted in much useful information about British developments.

Basic Radar.—This section is now well established and is developing good experience of basic microwave techniques. A project of developing microwave interferometry for measuring survey tapes in much the same way as light-wave interferometry is used for measuring very small distances has led to valuable work in frequency stabilization of microwave oscillators, which has applications in other related fields. Development work on radar receivers is yielding promising results, and an investigation into the properties of the gas-discharge tube as a low power source of radio energy suitable for testing radar receivers is progressing very satisfactorily.

Radio Research.—A considerable part of the effort in radio research is devoted to studies of the properties of the ionosphere, which have an important effect on communications between New Zealand and oversea countries. The equipment for studying winds in the ionosphere is now operating on a regular monthly schedule at the same hours as equipment at Cambridge and in North America. Statistical studies of the occurrence of ionosphere storms have continued throughout the year, and have shown some promise of helping in the prediction of such storms. New experiments have been devised and initiated for studying the progress of a radio wave through its various reflections at the ionosphere. The new ionosphere sounder designed to replace obsolescent equipment in the routine sounding service is being made in the workshops.

A novel instrumental technique for measuring medium-frequency radio field strength has been proved satisfactory by experiment; the principle is now being embodied in an improved model.

Electronics.—Three complete quartz crystal clocks for the time service have been delivered to the Seismological Observatory and are working satisfactorily. Apparatus for the mounting of quartz crystal wafers so as to obtain the performance required by recent international frequency agreements has been developed and supplied to the Post and Telegraph Department. Two special instruments have been developed for the Ministry of Works Hydraulics Laboratory: a novel electrical water-level recorder for use on models, and an experimental equipment for estimating by electrical analogy the flow and pressure of water near dams and in permeable foundations.

In addition to the frequency standard held by the Electrical Standards Section, this section maintains and is extending the facilities required for making frequency measurements. It has been established by experiment that the United States National Bureau of Standards transmissions from Hawaii can be used for testing the local standard with an accuracy of one part in ten million. Plans are being made for setting up a standard transmission on 5 megacycles per second.

The establishment of facilities for acoustic measurements is progressing; the demand for such work is increasing.

Electrical Design.—The section acts in a consultant capacity, especially on high-voltage pulse work and transformers, and contributes to numerous projects handled by laboratory sections. Much-needed advances in small transformer design and manufacture in New Zealand are being encouraged by the setting up of a pilot plant, with emphasis on adequate testing and on tropicalization.

The Marine Department was supplied with the design of a pulse generator for stunning the fish in a stream so that they could be counted and returned uninjured.

Electron Microscopy.—The importance and usefulness of the electron microscope are being increasingly appreciated by biological research workers and

others. The flow of requests for work is greater than the present two-man team can handle.

Joint research with Plant Diseases Division has shown that, contrary to general belief, the infectivity of a virus sample indicated by a microscope count of the virus particles differs from that found in practice.

A large number of electron micrographs of clays have been made for the Soil Bureau as part of the Bureau's survey activities.

An ultramicrotrome—an instrument for cutting sections of biological material thin enough for use in the electron microscope (order of 1/2000 millimetre)—has been made and is in use. No instrument of comparable performance and simplicity is known to exist overseas; the development appears to have commercial possibilities.

Previous studies of bull sperm have been supplemented by cinematographic studies of their motion. It is hoped by this means to contribute both to understanding of the behaviour of sperm and to the problem of distinguishing quickly between fertile and infertile bulls.

Plant Physics.—The basic problems posed by plant biologists are those of measuring humidity and temperature of soil and air within a few inches above and below the surface. Separate instruments for the two zones have been developed and are being tried. It is beginning to emerge that the reaction of a plant to moisture depends not simply on the amount of moisture present, but also, in some complex way, on the kind of soil.

PHYSICS DIVISION

Geophysics.—This section is responsible for the routine maintenance of geophysical survey equipment, and also for the development of new techniques and instruments applicable to geophysics. These have included during the year work on sensitive magnetometers for magnetic survey work, including one designed for use under water, a recorder of the seismic type for investigating the origin of the local earthquakes or " thumps " experienced in the thermal regions, measurements for the Geophysical Survey of the magnetic properties of rocks, and collection and analysis of records of power generated by a wind-driven generator.

Geothermal Investigations.—The work of routine observation on boreholes of temperature heat and mass outputs, etc., in the Wairakei area has been handed over to the Ministry of Works; but this section deals with more general physical observations on the thermal regions as a whole. Measurements of heat loss and water discharge from selected hot springs, fumaroles, geysers, etc., in the Wairakei area have been set up on a satisfactory basis for the observation of long-term trends. Future development areas, such as Waiotapu, are being surveyed with the object of obtaining long-term information both before and after the main drilling programme. From the analysis by means of the mass spectrometer of gases issuing from bores, hot springs, and fumaroles it is hoped that light may be thrown on the ultimate origin of the surface discharges.

Mass Spectrometer.—During the year the last of the developmental difficulties were overcome and the instrument became an effective unit for the analysis of gases and for biological and other research in which stable isotopes are used. These isotopes resemble radioactive isotopes in that their atomic masses differ from those of the common stable versions of the elements, but are not radioactive and so can only be detected by an instrument that discriminates between atomic masses. Since they do not decay, they are especially suitable for longer-term biological " tracer " work, as compared with radioactive isotopes, some of which have a very short life.

The research projects at present in hand are: analysis of gases from the thermal regions; survey of the heavy-water content of New Zealand natural waters; and, in co-operation with the Fruit Research Station, an investigation, in which heavy nitrogen is used as a tracer, into the nitrogen metabolism of apple trees.

Nuclear Physics.—The equipment for assessing the age of carbonaceous material from the proportion of carbon-14 isotope present in it depends on the principle that the carbon contained in living material contains a fixed proportion of carbon-14. When the material dies, the carbon-14, which is radioactive, decays very gradually until after 20,000 years its radioactivity is no longer detectable. Thus a measurement of its radioactivity indicates how long ago it died. The equipment is now working well and assessments have been made of the ages of some Taupo ash showers and of peat deposits near Auckland.

A programme of measurements of the radioactivity of waters, gases, and localities in the Wairakei area has been completed as part of the physical survey of the area.

Routine assistance is given to hospitals in the clinical use of radioactive phosphorus.

BUILDING AND CIVIL ENGINEERING RESEARCH DIVISION

Engineering Seismology Section.—An essential element in the programme of the section is the provision of strong-motion seismographs for observing the magnitude and frequency spectrum of damaging shocks for correlation with observed damage and measured characteristics of structures. One such instrument was developed and has been installed at the Laboratory, one minor shock having been recorded. The design, however, depended on the use of a number of complex components that must be purchased overseas, so, instead of proceeding to the manufacture of six as originally planned, effort has been diverted to the development of an equivalent instrument of less complexity and cost. The development is practically complete, and construction of the instrument now awaits the procurement of overseas components on a much-reduced scale. Two very simple and cheap types of strong-motion seismograph giving limited but still useful information are being developed. A shaking table for testing vibration-measuring instruments at low frequencies has been built.

Because of the special techniques maintained by this section, it receives requests for a considerable amount of assistance in the testing of engineering structures, mainly from the Ministry of Works. Extensive stress and vibration measurements were made at Maraetai Power Station in October during the initial river diversion through the penstocks. Stress and vibration measurements were made on the Panmure Bridge near Auckland under various traffic loads. Assistance was given to the Ministry of Works by provision of strain-measuring facilities during the testing of pre-stressed concrete beams before and during the Pre-stressed Concrete Conference in November. Measurements are being made of the pressure of the soil against the concrete structure of one of the Petone overbridges. Two articulated petrol tanks wagons were also tested under full load, both at standstill and in motion, for two oil companies.

Various techniques for measuring the strains induced by loads on structures are being developed. For concrete structures, the development of a special type of strain gauge for embedding in the concrete is continuing. For measurements on large structures, spread over long periods, acoustic strain gauges are being developed in which the stretching of a wire is estimated from the note it emits when plucked.

Building Physics and Heat Research Section.—During the year the officer in charge of the section spent six months in Britain and on the Continent studying the latest developments in the physics of the building industry. The large volume of information that he brought back has increased the scope and value of the information service that the section has been establishing in the endeavour to assist architects, builders, contractors, and even private home-owners, with advice and information in the fields of domestic heating and the physics of building materials. The steady and increasing demand for such assistance, as judged from the number of inquiries received, indicates that there is a real need for an information service, and that it can make an important contribution to the establishment of up-to-date and efficient techniques in the building industry.

In conjunction with a commercial firm developing electrical methods of space heating, the Laboratory has again given attention to this problem. Studies have been made of the performance of both a base-board heater and a ceiling radiator panel, and improvements have been suggested.

Assistance has been provided for a refrigeration engineering firm in a number of interrelated measurement problems associated with the firm's development of more efficient large-scale cold-storage plant. This work is recognized as offering potential advances of considerable economic value and has been accorded a high priority.

Concrete Research Section.—The main and most important project of the section has continued to be the work on proving New Zealand pozzolanas. These are naturally-occurring minerals which, when prepared by fine grinding, can be used in concrete to replace the cement in substantial proportions. From overseas experience, the use of pozzolanas is expected to result in concrete of improved stability and durability, especially for hydraulic applications. The tests done so far indicate that 25 per cent to 35 per cent of pumicite from the Waikato Valley, or 10 per cent to 15 per cent of diatomite from Otago, may be used instead of cement in concrete without loss, or, indeed, with some gain, of ultimate strength if a constant water/cement ratio is preserved. Investigations now in hand will extend the strength tests to concrete in which the water/cement ratio is varied to maintain constant workability of the mix—a rather more practical case. Tests are also under way to check whether the expected improvements in resistance to corrosion and abrasion, in water permeability and in drying shrinkage, are obtained. With the co-operation of a local manufacturer the practical application of pozzolana to the manufacture of sewer pipes has been tried on an experimental scale, and has given very promising results.

The section provides a service to concrete product manufacturers and local authorities, of which increasing use is being made, in the testing of manufacturing methods and products and advice on mix design.

PUBLICATIONS

Ten papers relating to the work of the Laboratory have appeared in technical journals, and sixteen Laboratory reports have been issued.

ENTOMOLOGICAL RESEARCH STATION

Director: Dr D. Miller

GRASS-GRUB (*Costelytra* spp.)

Parasites.—A report on a six-year search for parasites (*Thynnidae*) in Australia is being written ; four aspects have been completed, and two already published; the fifth aspect is nearing completion.

No attempt has been made during the year to examine the extent to which the Australian parasites have established in the several localities where liberated, because it would be unwise to disturb the insect at this early stage; however, one of the earliest liberated species seems to be establishing satisfactorily.

Nematode and Milky Disease.—The nematode *Neoaplectana glaseri* has not been recovered where liberated in the field; cultures of it have been made available, however, for trial against the rhinoceros beetle (*Oryctes*) in the Pacific islands. Studies on a native nematode of the same genus have been completed. Another species has been found in the hind gut of the grass-grub (*Costelytra zealandica*). Cultures of a New Zealand strain of milky disease are being tested for potential value against grass-grub.

Chemical Treatment.—It has been shown that where recommendations are being carried out properly treatment with Gammexane and DDT gave good control, except with DDT under drought conditions in the absence of water. On irrigated lands the treatment remains effective.

There are indications that some DDT is taken up by pasture plants. A series of tests on a number of crop plants showed that, though annual dosages had no permanent effect on most plants, high dosages of Lindane and crude Gammexane were injurious, but DDT less so; preliminary tests for germination of pre-treated cereal, grass, and clover seeds showed little repression with wettable DDT and dusts, but Lindane had a marked effect.

Dairy cows fed on pasture treated with Gammexane produced butter strongly tainted; even Lindane caused a definite taint, but there was no taint at all with DDT. Pastures receiving the recommended DDT-superphosphate treatment against grass-grub induced no taint symptoms. These experiments are carried out in co-operation with the Dairy Research Institute, the Wallaceville Laboratory, and the Dominion Laboratory.

DDT, Gammexane, and Lindane at normal annual dosages do not affect earthworms, though at much greater strengths they are slightly harmful.

Biology.—Egg-laying tests were carried out to ascertain the preference of beetles for different types of plant cover. Most infestation took place on pasture, whether long or short, though infestation did occur in fallowed land containing roots.

A study has been made of the incidence of grass-grubs on various soils in the Manawatu sand country. In the eight soil types examined there was an over-all predominance of the green chafer (*Pyronota festiva*) over the common grass-grub (*Costelytra zealandica*), the former being also the major pest in the region.

In light-trap experiments there was an overwhelming preponderance of male beetles of the grass-grub (*C. zealandica*)—386 males and 36 females.

An examination of sperms of three species of grass-grub revealed no morphological differences; a study is being made of symbionts of these beetles.

GENERAL

Grass Caterpillars (Oxycanus *spp.*).—These caterpillars were controlled by DDT treatments, even under drought conditions.

Manuka Blight (Eriococcus *sp.*).—It has been found that death of manuka (including ornamental varieties) is due to the feeding of the insect. The origin of the insect is still obscure, and it is unknown overseas; a description of it has been prepared for publication. The blight has been widely spread by farmers in both Islands and considerable areas of manuka are being destroyed. Control by sprays is simple and effective, but on a large scale the cost would be prohibitive.

Stored Products Insects.—Grain insects and mites were treated experimentally, and as a result an effective routine treatment of infested stores with DDT-Lindane mixture was devised.

Clover Case-bearers (Coleophora *spp.*).—The biology of these moths is being studied in the field and laboratory. Consignments of three species of parasites (*Habrocytus milleri, Angitia majalis,* and *Pristomerus orbitalis*) have been received from Europe. These have then been reared in New Zealand and liberations have been made in the field.

Lucerne.—The insects of lucerne are being studied to ascertain their influence upon the crop, and several destructive insects have been located. Observations indicate that honey-bees are inefficient pollinators, and that the density of humble-bees is much too low to give a satisfactory setting of the seeds.

Humble-bees.—A study of the humble-bee position in relation to red clover is being carried out in the Manawatu in order to determine the seasonal cycle of species and the density of population, preparatory to the introduction of further species.

Phormium.—Work continues on relationship between the yellow-leaf disease and the insect vector (*Oliarus atkinsoni*), and other possible vectors are also being studied. Insects directly harmful to phormium are being dealt with in addition.

Green Vegetable-bug (Nezara viridula).—The position of the egg parasite (*Microphanurus basalis*) has been examined; it is found to be well established at various points, and there are indications that it is exercising a marked control of the pest. The parasite has been distributed to new regions.

Oak-leaf Miner (Lithocolletis messaniella).—This insect is being studied preliminary to securing parasites from Europe for its control. Apart from damage to oak trees, there are indications that it could be a serious pest of native *Nothofagus* forests.

Apple-leaf Midge (Dasyneura mali).—This recently introduced pest is being examined with a view to its possible control by parasites.

Raspberry.—It has been found that grass-grubs can be a serious pest of raspberry plants by destroying the fibrous roots; when grub population is high (300 to the plant) a " die-back " condition is produced.

Miscellaneous.—Attention has been given to the insects injurious to tobacco and hops. A scale insect (*Parlatoria pittospori*) has been studied in regard to its effect on apples and *Pinus radiata*; the scale appears on apples as soon as they form.

PUBLICATIONS

Eighteen papers have been published during the year.

FATS RESEARCH LABORATORY

Director: Dr F. B. Shorland

While investigations to supply basic information on the composition of butterfat have been continued, increasing emphasis has been placed on the study of fats present in meat. These fats exceed in weight those of our butterfat, and there is still very incomplete information regarding their nature. The importance of the study of fats in our exports generally may be realized from the fact that they comprise more than 70 per cent of the dry weight of our foodstuffs.

BUTTERFAT

Work on the fatty acid composition of butterfat samples taken at intervals over several years has now been published, and this information, together with

the results of the Dairy Research Institute (N.Z.), has provided a general picture of the seasonal changes that occur in New Zealand butterfat. At the same time these studies have shown that there is no correlation between the hardness of butterfat and its fatty acid composition, and for the proper understanding of the physical properties of butter it will be necessary to elucidate the seasonal changes in glyceride structure. Attempts are being made in this Laboratory to devise new and improved procedures for this purpose.

Investigations on the nature of C_{20-22} highly unsaturated acids, which are present to the extent of about 1 per cent in butterfat, are being continued. In collaboration with the Nutrition Research Department of the Otago Medical School, the nutritive and other biological properties of the C_{20-22} highly unsaturated acids and of the branched-chain fatty acids discovered in animal fats by this Laboratory are being examined by means of animal-feeding experiments.

Lauric acid, hitherto suspected as a constituent of butterfat, has now been isolated and identified.

MEAT FATS AND TALLOW

Studies on mutton tallow show that there are present many minor constituents that had hitherto escaped the observation of other workers. Branched-chain fatty acids, including d-12-methyltetradecanoic acid, 13-methyltetradecanoic acid, d-14-methylhexadecanoic acid, and a C_{17} acid containing two methyl or homologous side chains, have been isolated in this Laboratory from mutton tallow.

In association with the Dominion Laboratory's dehydrated-meat project, an investigation is being made of the changes in fats during processing and storage. Some preliminary work has been started on the elucidation of the nature of the complex lipids in the fats of the muscles and organs of beef animals.

Because of the low stability of mutton tallow and the earlier complaints from Great Britain on the quality of this product, continued attention has been given to the study of antioxidants, particularly in regard to the use of additives that are harmless and likely to meet with the approval of the British Ministry of Food. It has been found that citric and tartaric acids have a greater stabilizing effect on animal fats than hitherto supposed. Citric acid is not readily incorporated into fat, but this difficulty has been overcome by using the mixed glycerol esters of citric acid and fatty acids (New Zealand patent applied for).

MISCELLANEOUS

There have been numerous problems arising from inquiries by various industries in which fats and oils are used. Linoleic and linolenic acids, which are not readily available, were isolated in the Laboratory for the Department's use in feeding experiments, and for the needs of industry. In response to a request, the composition of some New Zealand linseed oils was investigated to determine possible correlation between wrinkling and the content of linolenic acid. Studies were made on the saponification of wool grease and on the development of an industrial method for the isolation of cholesterol. The isolation in this Laboratory of traces of a multi-branched C_{18} saturated fatty acid in the liver oil of the shark (*Galeorhinus australis*) provides further evidence of the widespread occurrence of branched-chain fatty acids in natural fats.

Several new designs for equipment for the work of this Laboratory have been developed. These include a solvent evaporator for a rotary vacuum pump; the introduction of a vapour jet for the removal of occluded air in condensation pumps, thereby improving the vacuum; and a simple and effective design of packing for vacuum fractionating columns.

The Director visited Australia, Great Britain, several European countries, and the United States, and collected much information regarding the progress of fats research in these countries, which will be of great benefit to the work of this Laboratory.

During the year nineteen papers have been published, mostly in overseas journals.

FRUIT RESEARCH STATION

Director: Mr J. D. Atkinson

An unusually wet spring and early summer hindered field work and upset some of the experimental programmes. These adverse conditions proved of some use, however, for they showed up certain weaknesses in new methods and emphasized the need for caution in recommending radical changes in orchard practice. Throughout the year the Station handled a steady demand for advice on identification of physiological disease specimens and fruit varieties, mostly from extension officers of the Department of Agriculture. In all, some 200 disease specimens were examined and over 100 varieties of fruit identified.

PLANT HORMONES

Chemical thinning with hormone sprays was less successful than in the two previous years because serious leaf and fruit injury occurred. It has, however, been demonstrated that variety, tree vigour, and season cause marked variation in tree response. There is some evidence to show that the tendency to biennial bearing can be appreciably reduced by chemical thinning. Anti-drop hormone sprays are now an accepted aid to harvesting, and they have not seriously affected storage quality. Stem-end rot in lemons has been appreciably reduced by hormone treatments that prevent stems falling out during the curing and storage period.

Wide use of hormones on tomatoes under glass has caused two new problems. The most serious of these, increased infection with the fungus *Botrytis cinerea,* has been tackled as a co-operative investigation with the Plant Diseases Division, and promising results have been obtained with spray treatment. Fruit hollowing, the second problem, appears to be caused by excessive amounts of hormone reaching the plant, but no sure way of avoiding it has yet been devised.

FRUIT NUTRITION

Zinc deficiency in pears and manganese deficiency in apricots have been diagnosed and successfully treated in the field. It is now becoming clear that manganese deficiency is widespread in several fruit districts, and that zinc deficiency occurs over a considerable area round Alexandra: adding these two elements to deficient trees will materially improve the yield of fruit. Seventeen other diagnostic trials are in progress, most of these being in collaboration with the Horticulture Division of the Department of Agriculture. Considerable progress has been made with work designed to elucidate the nature and amounts of nutrients moving in the sap from apple rootstocks to scions. The pattern of seasonal variation in amount has been plotted, and it is now known what nitrogen compounds are present in sap. Results from a limited number of total analyses made on leaf material have shown poor correlation with tissue-test figures from petioles of the same leaves. This suggests that the tissue-test method must be modified before it can be used to diagnose manurial requirements of apple trees.

POMOLOGY

Stone Fruit.—Losses from disease and death have made it necessary to select fresh budwood trees to supply high-grade budwood to the nursery of the New Zealand Fruitgrowers' Federation, Ltd. To make this selection as reliable as possible a study is being made of the effect of climate on fruit type. Considerable assistance with this work has been given by the Horticulture Division.

Since changed methods of canning peaches have practically eliminated the normal supply of peach seed from which seedlings for use as rootstocks were raised, attempts are being made to propagate them in other ways.

In co-operation with the Crop Research Division, pollination studies of some plum varieties have been undertaken with the object of finding ways of overcoming the shy bearing habit of certain good varieties.

Citrus and Sub-tropical Fruits.—Several tangelo varieties have shown some promise under Auckland conditions, and, in collaboration with the Horticulture Division, trees have been planted out in various citrus districts. Trees in the sweet orange, Lisbon lemon, and grapefruit rootstock trials are nearing the age when a preliminary assessment of stocks can be made. In company with extension officers, searches have been made for virus diseases and for improved strains of sweet orange. Some virus-like symptoms and a few promising sweet-orange trees have been discovered. A full report on the handling and marketing of the lemon crop in California was prepared for the Marketing Department. Seedlings of the large-fruited guava have proved unsuitable under Auckland conditions: fruit is produced, but crops are light and quality poor.

Apples and Pears.—The extensive apple rootstock and varietal plantings have been maintained in good order. Because *Phytophthora cactorum* is now recognized as a serious root parasite of apples, the resistance of all rootstocks used in New Zealand is under investigation by a team drawn from the Plant Diseases Division and the Fruit Research Station. Several local seedling apples that show promise have been added to the varietal collection for testing. Methods of inducing fruiting in excessively vigorous trees are being studied. Increased attention is being given to the problem of raising good varieties on their own roots. A pear rootstock trial has been planted out at Havelock North.

COOL STORAGE

Four new experimental chambers provided by the New Zealand Apple and Pear Marketing Board are nearing completion. These will permit an expanded experimental programme designed to solve the more important cool-storage problems. During the current season, work has been concentrated on determining the conditions necessary for successful export of William Bon Chretien pears and on the influence of chemical thinning on storage quality. A second trial of delayed storage of Sturmer apples confirmed that this practice seriously reduced their keeping quality. A bulletin summarizing the findings of storage experiments in New Zealand during the past thirty years has been prepared for publication.

FROST

Trials of a hormone material claimed to protect trees from frost demonstrated that it was not effective on apricots under Otago conditions. Over one hundred replies were received by the New Zealand Fruitgrowers' Federation in response to their offer of a prize for a new method of frost control. In most cases the proposals were too costly, but three devices that appear

to have some promise are awaiting field test. Lighting-up times determined from artificial freezing trials on the buds were used again on a field scale in blocks of apricot trees. For the third successive year this guide proved reliable, very little fruit being lost from trees in the trial blocks.

FRUIT TREE VIRUSES

This work is run as a co-operative project by the Plant Diseases Division and the Fruit Research Station. During the year attention has been concentrated on attempts to identify the various virus-like symptoms found in the field during the past two years. A check is also being kept on the N.Z.F.F.L.'s nursery, and, where virus symptoms appear, the source of infected material is eliminated.

MISCELLANEOUS

It was shown that the death of some large apricot trees in Otago orchards was caused by fuel oil draining down the bark from firepots stored in tree forks. Affected trees were beyond recovery, but now that the cause is known no further trees need be lost in this way.

PUBLICATIONS

Twenty-one papers prepared by the staff were published during the year, and a further fifteen papers have been accepted for publication. These are distributed through five New Zealand and two United Kingdom journals.

GEOLOGICAL SURVEY

Director: Dr L. I. Grange

During the year the Director visited all the district offices, and gave particular attention to geothermal investigations.

Unfortunately the Survey lost the stocks of many of its publications by fire in the Hope Gibbons Building, in which they were stored. The acquisition of an additional building in Boulcott Street within a short distance of the Survey office is a decided improvement on previous accommodation. Nevertheless, it is a matter for regret that the original records of almost a century's effort of the Survey, the irreplaceable library, the comprehensive paleontological collection, and the petrological specimens are still not housed in reasonably fireproof buildings.

DISTRICT OFFICES

North Auckland.—The geology of Maungataniwha Subdivision has been written, and work on Whangape Subdivision is progressing. Limestone for agricultural use has been investigated at Waimate North; water-supply problems for Education Boards, the Forest Service, Kaikohe Borough Council, and private supplies, have been investigated, and recommendations made for obtaining adequate supplies from groundwater or perennial streams where feasible. The Ngawha hydrothermal area was inspected to ascertain if the supply of hot water could be augmented, but the groundwater heated by thermal water is too limited in extent to yield any considerably increased supply.

Ngaruawahia.—The survey of the Waikato Coalfield is completed, and a detailed description of the coal measures will be given in a bulletin describing the geology of sheets N 52, 56, and 65 now in course of preparation. Within the Glen Massey district no additional reserves of coal of sufficient extent to replace Wilton State Mine have been discovered. The Retaruke and Kawhia coalfields have been investigated: Retaruke seams are too high in ash to be marketable,

and in the Kawhia field workable coal is known, but its extent is decidedly limited.

In collaboration with the Mines Department, the Maramarua area was investigated in detail at the request of the Ministry of Works, and prospect drilling for sufficient coal for a steam electric generating plant has proved that there are 33·5 million tons indicated and 20·8 million tons inferred; these coal reserves exceed the immediate requirements of the Ministry of Works.

Subsurface water supplies in the Pukekohe district were investigated to ascertain the possibility of sea-water infiltration and depletion of perched groundwater; at the present rate of consumption there is little danger of either, but such possibilities will have to be guarded against with increasing use of groundwater. Artesian water supplies have been investigated in the Waikato district.

An area of marginal grade sulphide in the Thames district was examined as a possible source of sulphur for the fertilizer industry; the area will have to be drilled and sampled to establish the grade and quantity available.

Rotorua.—The bulk of the year's effort has been directed to the development of the geothermal resources of the Rotorua-Taupo district, more particularly in co-operation with the State Hydro-electric Department on the Wairakei project. At the request of the Ministry of Works a report was prepared on a drilling programme to produce steam for a generating station of 20,000 kW. capacity; an area of 2 square miles was indicated in which shallow production from wells 1,500 ft. deep could be recommended. Observations are being made to find out if the drillholes affect the thermal activity in Geyser Valley.

In connection with the proposed production of heavy water, short reports, with recommendations for preliminary investigation and development, were prepared on the thermal areas of Orakei-Korako, Te Kopia, Waikite, and Waiotapu.

Dam and power station sites, quarry sites for aggregates, and materials suitable for pozzolana have been investigated for the State Hydro-electric Department.

Drill sites for potable and thermal water have been indicated for Government Departments and private supplies.

As opportunity permitted, field work on Tongariro Subdivision was undertaken, and the eruptive activity of Ngauruhoe recorded. Considerably more systematic investigation extending for many years over the whole of the volcanic zone is necessary to ensure that any symptoms of impending activity may be appreciated and heeded—should such a goal in volcanological research be possible to attain.

Napier.—In the Hawke's Bay district more time has been devoted than formerly to the study of subsurface geology in relation to water supply, and reports bearing on supplies for Crown land settlement have been furnished to the Ministry of Works and the Department of Agriculture.

Problems with industrial and domestic supplies have been attended to. Foundation rock for a hospital site and main highway location have been investigated.

Erosion problems in relation to soil conservation were studied at the request of the Ministry of Works. Headwater erosion by the major rivers, with consequent aggradation and the possibility of serious flooding in the lower reaches, are a hazard to some of the more densely populated areas.

Limestone for agriculture and pozzolana for cement have been investigated.

The land surface of extensive areas in northern Hawke's Bay has been progressively warped, as is shown by a study of Lands and Survey data, and changes in elevation of up to 30 ft. have occurred over the sixty-year interval between successive surveys.

Christchurch.—Considerable progress has been made with the collection and compilation of information for a bulletin on the geology and groundwater resources of Mid-Canterbury. This will incorporate work done for a large number of special investigations during the last few years. Recent work confirms earlier conclusions that leakage of irrigation water has been small and that, except locally and for short periods, the water table has not been raised significantly. Other studies of groundwater in Mid-Canterbury relate to land drainage and water supply. The great natural fluctuations of water-table level, largely dependent on variations in rainfall, affect the design of drainage schemes and the depths of wells for water supply. In many areas at present inadequately supplied with water, ample groundwater is available for development for domestic and stock supplies, and perhaps also for irrigation.

In collaboration with the Ministry of Works, groundwater conditions in existing and proposed irrigation areas in Canterbury have been investigated. Periodical water-level measurements in observation wells in unirrigated areas have been made for comparison with similar records in the irrigated areas. In this way any evidence of seepage from irrigation channels or from excessive irrigation will be obtained. The programme of water-level measurements also serves a wider purpose in that it is a means of obtaining information on the source and movement of groundwater. The information obtained will be of value in the design of drainage schemes, and also in giving early indication of any excessive withdrawals of groundwater.

The supply of hot water at Maruia Hot Springs, Nelson, was investigated for the Tourist Department. It appears to be quite adequate for the development of the area as a tourist resort.

Investigations into the occurrence and availability of groundwater have been made at the request of Government Departments (the Ministry of Works, Railways, Agriculture, Health, and State Hydro-electric), local bodies, industries, and private persons (mainly farmers). Other requests for information and advice have been met from information already recorded. In many cases written reports have been prepared. About a hundred of these inquiries have been dealt with during the past year, showing an increase in the demand for this type of advice.

Clays for brick and pipe manufacture have been investigated at Whitecliffs, and information on Canterbury bentonites compiled. Quartz sands for glassmaking were examined in the Castle Hill Basin. Limestones for agricultural use at Mount Somers, Staveley, Cavendish, Scargill, and the "Curiosity Shop" (near Hororata) were investigated and reports written. Information has also been given to inquirers on other Canterbury mineral resources, including diatomite, sand for mortar, and materials for concrete aggregate, and the manufacture of sand-lime bricks and cement.

Greymouth.—The survey of the Reefton and Garvey Creek coalfields has been extended to cover the area of National One Mile Sheet S 38, and the bulletin describing the geology is being prepared. Reports on these coalfields and estimates of reserves have been prepared. Collaboration with the Mines Department and co-operative parties has been maintained in the development of West Coast coalfields, and a report has been written on the prospects for coal mining in Collingwood district. A detailed report on the distribution of coals of different coking properties within Paparoa Mine was prepared for the Mines Department at the request of the Christchurch Gas, Coal, and Coke Co.

Limestone at Jackson's Bay was shown to be suitable for top-dressing and will provide a convenient source of lime in this isolated district.

Aggradation in the Waitangi River bed was investigated for the Catchment Board and was found to be caused by rapid erosion of steep schist country, shattered by movement on the Alpine Fault.

Invercargill.—Field work for the Hauroko Bulletin covering Sheets S 167 and S 175 was completed, the maps were drawn, and the text is being prepared. Field work is progressing in an area covered by nine contiguous National One Mile Sheets in south Central Southland. Within this area are extensive deposits of limestone suitable for top-dressing and cement manufacture; the survey will also indicate the extent of the southern lignites and yield information on the availability of subsurface water.

Close collaboration was maintained with the Mines Department in prospecting and developing the Ohai and Kaitangata coalfields.

At the request of the Ministry of Works, particular problems arising during the development of Roxburgh hydro-electric scheme were investigated; a report was prepared on the outlets of Lake Hawea.

In co-operation with the Soil Bureau, the area covered by the Maniototo irrigation scheme was inspected and sites were chosen for drillholes to observe groundwater conditions and the possible effects of irrigation on the water table. With the N.Z. Pottery and Ceramics Research Association, good ball clays were discovered in Ohai and Central Otago.

PALEONTOLOGY

The paleontologists spent much of their time servicing field geologists and working on the preparation of departmental and other publications. The routine service work brings to light many problems for research, but the time left for such original work is inadequate to do it justice.

Research was undertaken on Tertiary Foraminifera and Ostracoda from the Oamaru and Wanganui districts, on the first Jurassic Foraminifera recorded from New Zealand, and on fossils in phosphate nodules collected by R.S.S. *Discovery II* from the sea bed east of New Zealand. Detailed studies were made of two groups of fossil molluscs. North Auckland Permian corals were identified; and Dr D. Hill, University of Queensland, reported on Devonian corals from Reefton. Paleobotanical work included a study of Mesozoic and Tertiary spores and pollen grains, the zoning of the Ohai coal measures, and identification of fossil leaves and seeds from several districts.

A bibliographic index of New Zealand stratigraphic names was completed.

The Survey's fossil collections, particularly those of Foraminifera, received a good deal of curation for more efficient use. Specimens were supplied to the Universities and exchanged with overseas institutions. Special collections were submitted to overseas authorites for report, including specimens for isotope analysis to determine the temperatures of ancient seas.

PETROLOGY

Service work for the district geologists, for the Geological Survey bulletins, and for Government Departments has occupied a considerable amount of the time of the Petrology Section. Many examinations have been made to test the suitability of aggregate materials for use in all the main hydro-electric projects, for the Murupara scheme, and the Tauranga Harbour works. Cores from the drilling at Wairakei were studied to assist the geothermal investigations. Numerous petrographic examinations were undertaken to further the use of pozzolanas and perlite, and the possible utilization of dunite in the production of fertilizer. The Rimutaka tunnel was inspected regularly. The Survey's assessment of the radioactive minerals in New Zealand was confirmed by Dr C. F. Davidson, of the Geological Survey of Great Britain, and Mr R. D. Ninninger, United States Atomic Energy Commission, on their visits. The section co-operated closely with the Dominion Laboratory in the identification of minerals and oil residues, the examination of moulding sands, and the study of materials that may cause silicosis.

ECONOMIC AND ENGINEERING GEOLOGY

Deposits of pumice and diatomite, the two types of material in New Zealand that so far have proved by standard tests to be suitable for pozzolana, have been investigated in collaboration with the Dominion Laboratory and the Dominion Physical Laboratory. There is a wealth of pumice over extensive areas of the North Island and apparently considerable reserves of diatomite in the Rotorua district; so far, the only satisfactory material known in the South Island is diatomite, of which the known reserves are small.

In conjunction with the N.Z. Pottery and Ceramics Research Association, extensive felspar resources of satisfactory grade for ceramics have been located in the South Island. Extensive deposits of dunite suitable for the manufacture of silico-phosphate fertilizer have been proved in Dun Mountain, and adequate reserves of serpentinite are known in the South Island; the bulk of these rocks are unfortunately distant from centres of fertilizer manufacture.

Ores of copper and manganese reported in the Pohangina district proved to be of no value, and appear to have been derived from pillow lavas, or submarine flows interbedded with the greywacke of the Ruahine Range.

TECTONICS

Scarplets, indicating fairly recent movement along faults, have been noted in New Zealand since the eighties, more particularly in the north-east of the South Island; present knowledge of their extent shows that they are comparatively numerous in the seismically active area extending southwards from the Bay of Plenty and East Cape and embracing the northern third of the South Island. They are not unknown in other areas considered seismically stable, and, where lacking, ancient landslides are of such extent and magnitude as to suggest that they were earthquake engendered, as in Central Otago and possibly Huntly district; North Auckland is the only area lacking evidence of past seismicity, but it is probable that such evidence will ultimately be forthcoming. A study of some of the major faults in the South Island has shown that for the last 10,000 years displacement engendering earthquakes has taken place at an average uniform rate. It is likely that this rate will continue without change into the future, so that the interval between major earthquakes is likely to be the same as in the past. An attempt is being made to find out what this interval is.

PUBLICATIONS

During the year four bulletins and thirty-seven papers in scientific journals, written by members of the staff, were published.

GEOPHYSICS DIVISION

Superintendent: Dr E. I. Robertson

GEOPHYSICAL SURVEY

Director: Mr N. Modriniak

Geothermal Investigations.—The programme of surveys in the Rotorua-Taupo thermal area has been continued.

A comprehensive investigation was made of the Te Teko area in the search for natural steam. Seismic, electrical, magnetic, and gravity prospecting methods and shallow drilling were employed. Heat output measurements were made on a bore in this area.

In the Waiotapu area a commencement has been made on investigations of near-surface structure. A series of tests was carried out to permit an evaluation

of the seismic method of prospecting. Reflections were obtained in widely separated areas: this will permit a structural investigation of the Waiotapu basin, and should materially assist in the elucidation of the geological conditions there. Shallow prospecting by drilling commenced in the area to the west of the Waiotapu Hotel to determine the heat potential for industrial use in this restricted area.

The gravity survey of the Rotorua-Taupo area was continued.

Heat output measurements were made at Rotorua on the High School bore, the Nurses' Home bore, and the Forest Service bore at Waipa.

Assistance was given to the Forest Service by drilling the Waipa steam bore.

The geothermal possibilities of Edgecumbe and Ngongotaha were considered with the view of supplying natural heat to dairy factories.

Regional Surveys.—The gravity survey control network was extended to the northern part of the South Island. Work on the results of the North Island survey was continued in preparation for publication.

The regional magnetic survey was extended to the north of Hokianga Harbour.

Local Investigations.—The proposed dam site at Pararikі was made the subject of a magnetic study, and the northern abutment of the proposed Ohakuri Dam was studied seismically.

Well-velocity surveys were carried out in Bore 13, Wairakei, and Omata Well, New Plymouth. This work provides essential information needed in the interpretation of seismic observations.

The possibility of determining the depth of peat near Te Aroha by electrical methods was investigated. Although this method could be employed, it was found that hand drilling is a more economical approach.

Magnetic surveys were commenced to assist in the search for water supplies at Kaikohe.

A seismograph has been installed at Ngapuna, near Rotorua.

Research Projects.—Apparatus was constructed for shallow seismic work involving frequency and amplitude, and tests were made in the Wainui-o-mata tunnel. It is hoped that the application of these methods will be beneficial to engineering and shallow reflection problems.

Convergence measurements were begun towards the end of the year in the Dobson and Wallsend State coal mines, in conjunction with the Mines Department.

The Survey also assisted in the crustal structure investigation undertaken by the Seismological Observatory.

GEOPHYSICAL OBSERVATORY

Director: Mr J. W. Beagley

International co-operation has been continued by the maintenance of the recording station under the control of the Geophysical Observatory. The successful interpretations of the many complexities and variations shown by upper atmospheric phenomena and related subjects call for endeavour on a world-wide scale in the accumulation of a long series of data for analysis. New Zealand's uniquely placed stations in the Southern Hemisphere are making valuable contributions to these studies, which are of international interest and benefit.

Ionospheric Recording.—Information obtained from the ionosondes situated at Lincoln, Rarotonga, and Campbell Island has been supplied to organizations both within New Zealand and overseas.

New and more efficient aerials were erected at Lincoln, Campbell Island, and the Godley Head auxiliary station.

Early in December the Lincoln recorder was extensively damaged by lightning. The necessary repairs have been effected, and considerable work has been done in reconditioning and improving the equipment at the various stations.

The replacement ionosphere observer for Rarotonga was trained in the necessary techniques. As part of the new co-operative scheme for maintaining the scientific activities on Campbell Island, the party leader and two meteorological observers received sufficient instruction to enable them to assist the two ionosphere observers in their work.

Cosmic Radiation Recording.—The Compton-Bennett ionization chamber continued to give satisfactory operation, and data was forwarded to the Carnegie Institution of Washington and other organizations.

The investigation of the diurnal variation in the north–south direction was completed with the MU2 recorder. For an east–west asymmetry experiment the recorder was moved to more suitable premises, and a turntable was installed so that the gear (which weighs about 30 cwt.) could be rotated easily and automatically if necessary. The installation and operation of the vertical-intensity recorder which was sent to Samoa has been delayed.

Other Activities.—Recording programmes in terrestrial magnetism and seismology were continued at Apia on behalf of the technical sections of the Division primarily responsible for this work. Data in these spheres have been made available to research organizations throughout the world. Tidal observations, measurements of sea densities and temperatures, made in Samoa on behalf of the United States Coast and Geodetic Survey, have been maintained, and the information obtained forwarded regularly to the Survey and to Oceanographic Observatory, Wellington.

Earth-current recording on north–south and east–west lines has been very spasmodic because of requirements for the equipment elsewhere. This work is to be completed with some experiments on the sea-coast near Amberley.

To assist in siting ionospheric equipment in the proposed new camp at Campbell Island, tests for mutual interference were made in conjunction with the Meteorological Office in the vicinity of their radio-sonde apparatus at Hokitika.

The Apia magnetic and meteorological data for 1950 was completed and forwarded for publication, and that for 1951 has been finished and awaits arrangement before going to the printer.

Research.—The Lunar variation analysis of the magnetic elements at Amberley has been finished and is being prepared for publication.

Progress has been made in the analysis of the data obtained from the north–south experiment with the MU2 recorder.

An examination of the incidence of E-Sporadic recordings at Lincoln and Godley Head has been commenced. To form the basis for an investigation into the changes that occur in the layer thicknesses and ionic densities of the various regions in the ionosphere during disturbances, a determination of the characteristics—recombination and attachment coefficients, effective rate of electron production, etc.—at Lincoln, Rarotonga, and Campbell Island was started. The variation of these with season, sunspot cycle, etc., should help towards an understanding of the basic reactions taking place in the upper atmosphere.

Visits.—Mr J. A. Ratcliffe, Reader in Radiophysics at the Cavendish Laboratory, spent two half-days at the Observatory investigating the various activities, and gave helpful advice in connection with research work being undertaken.

Sir John Cockroft inspected the cosmic-ray installations at Christchurch, and the Lincoln ionosonde.

Together with the Superintendent, Geophysics Division, and the Director, Magnetic Survey Branch, the Director discussed New Zealand geophysical

research with Professor Sydney Chapman when he passed through Auckland after the U.R.S.I. Conference in Sydney.

The Director visited Campbell Island to inspect the ionospheric installation, and Apia Observatory and Rarotonga Ionosphere Station for supervision purposes.

MAGNETIC SURVEY

Director: Mr H. F. Baird

Magnetographs.—Operation of the magnetographs at Amberley was continued. Daily and transient changes at Chatham Island were found to be in the same order of magnitude as at Amberley. Consequently such changes seem likely to be similar all over New Zealand. From the Amberley curves average hourly values were measured and an index of magnetic activity was derived for every three hours. The former are published in annual reports for future statistical research, but the latter are posted weekly to local experts, and monthly by air mail to overseas investigators of solar radiation and ionosphere conditions.

Navigation Charts.—Navigation charts and data were again supplied to the Marine Department, the Air Department, and the Royal New Zealand Navy. Since 1929 knowledge on the rate of change in compass directions in the South Pacific has been inadequate. But in 1952 control observations over some of the area were restored when the Air Department took one of the Magnetic Survey observers on a routine flight. He observed current magnetic values on the airports at Norfolk Island, Nandi, Faleolo, Aitutaki, Rarotonga, and Bora Bora. At Suva and Apia observations were also made near sites where officers of Carnegie Institution, Washington, had made them long ago. Observations in future at these airports and elsewhere in the Pacific will ensure reliable check on compass drift and on important aspects in international research. Early in 1953 magnetic stations were reoccupied on Chatham and Campbell Islands. Compass drift of 1 degree increase now takes four years in the subantarctic and nearly twenty in the tropics, but it is variable and unpredictable. These periodic observations are used by the Astronomer-Royal in England, and by Government agencies in the United States, when preparing global magnetic charts.

Daily Variations.—With the use of QHM and BMZ equipment recently bought from Denmark, changes in magnetic forces and directions at Chatham Island through the day were found to be quite similar to those at Amberley. A limited amount of such data was also secured on Campbell Island.

Aeromagnetics.—The airborne magnetometer has been grounded all the year while certain improvements have been made to integral parts. Useful charts from its flights over the thermal area were completed. To relate that investigation to adequate base values at Amberley, flights were made from near Christchurch to White Island. On final reduction those flights have revealed much new geological information, particularly on a major feature extending from Nelson across the sea bed on to western Auckland. Recent land observations reveal continued magnetic disturbance over formations from Tophouse to Owen Junction, but practically none from Sullivan's Bridge through the Shenandoah to Springs Junction. For chart-making purposes near the coastal parts of this Nelson disturbance and around Foveaux Strait the Survey and the Marine Department need further aeromagnetic data. Some inquiry has been made about the suitability of Devon aircraft for such work.

Seismology.—All records obtained in over fifty years' local service in this field have been sent to the Seismological Observatory (Wellington), on whose behalf the seismographs are now operated by the Survey.

Climatology.—Climatological data accumulated at Christchurch each day for more than fifty years are being used increasingly. Legal and insurance interests make many demands on them. The long series of wind records have been of special interest to the City Engineer. Information has also been supplied to local industrialists, heat engineers, and printing concerns.

Apia Observatory.—This branch is now responsible for technical control of the magnetic programme at Apia. In mid-1952 an officer intercompared standards at Apia and Amberley with instruments sent from Denmark especially for such international intercomparisons. The instruments were then sent to Australia, with whom we have very close liaison in this sphere. This scheme ensures that navigation charts over the South Pacific all relate to one international standard. An experienced graduate officer transferred from Christchurch to Apia early in 1953.

Publications.—Several scientific papers were published during the year; they devolved mainly from the recent magnetic resurvey of New Zealand and the aeromagnetic programme, both of which gave extended basic data of geological interest. The most noteworthy publication was " Magnetic Resurvey of New Zealand at epoch 1945.5 ". By request of the Education Department, sets of charts were sent to all major secondary schools, and many overseas scientists expressed appreciation of its usefulness in world researches.

SEISMOLOGICAL OBSERVATORY

Director: Mr R. C. Hayes

Seismology

Summary of Seismic Activity in New Zealand in 1952.—During 1952 earthquake activity was comparatively low, and still showed signs of decreasing at the end of the year. There were no outstanding seismic disturbances. Early in the year several shocks originated at considerable depth beneath the region north and north-west of Lake Taupo. Activity was more or less continuous in various parts of Hawke's Bay region. The largest shock, which occurred on 28 August, was centred near the coast of southern Hawke's Bay and reached instrumental magnitude near 6. It was felt over most of the southern part of the North Island, with maximum intensity M-M 6 in the Havelock North area. Several other shocks during the year reached felt-intensity M-M 5 in southern Hawke's Bay. Some earthquakes originated off the west coast of the South Island between Cape Foulwind and Milford Sound, a region generally almost inactive. The strongest shock of this series occurred on 3 November, and reached intensity M-M 5 in the Hokitika area. On 14 September a shock in Marlborough Sounds reached intensity near M-M 6 in the vicinity of Picton. During August a series of small very local shocks was recorded by the Wood-Anderson seismograph at Karapiro, the strongest ones being felt slightly in the surrounding region. It is thought that they probably originated in the Morrinsville-Matamata area, where there have been occasional outbreaks of earthquake swarms in the past. During the year 83 shocks were reported felt in New Zealand, 64 in the North Island and 26 in the South Island. Seven were felt in some part of both Islands.

Seismograph Stations.—A seismograph was installed at the Chateau Tongariro in October. Initial difficulties have been particularly troublesome with this installation, and several subsequent visits were necessary to rectify technical faults. The long-period Wood-Anderson seismograph, intended for installation at Apia, remained on test at this Observatory throughout the year owing to excessive tilting of the seismometer, which has not so far been completely rectified.

Visits of inspection were made to the seismographs at Auckland, Karapiro, Tuai, New Plymouth, and Bunnythorpe.

Deep Crustal Structure Project and Other Field Work.—Investigations of North Island crustal structure by submarine explosions in Wellington Harbour were carried out in March, in co-operation with other sections of the Division. A considerable amount of work was done on the measurement of the records, but difficulty was experienced in correlating the interpretation of various individual observers, and a satisfactory agreement on structure had not been reached by the end of the year.

Other field work included seismograph-site testing at Rotorua, and ground-vibration studies in the vicinity of Karapiro and near the Dominion Physical Laboratory, Lower Hutt.

Earthquake Reports.—In order to supply early information of earthquakes likely to have caused any structural damage in some part of New Zealand, a two-weekly earthquake bulletin was instituted in November. These bulletins are distributed as required, a copy being supplied to the Earthquake and War Damage Commission. Arising out of this project, Kerridge-Odeon, Ltd., have arranged for reports of felt earthquakes to be sent to this Observatory by the managers of theatres under their control in various parts of the country.

Epicentre Location.—A special stereographic map was constructed of the south-west Pacific together with a set of tables for the principal seismograph stations in the region. This enables rapid epicentre locations to be made with better accuracy than is possible by plotting on a globe.

Time Service

Transmission of Time Signals.—No changes were made in the system for transmitting time signals. The average error of the ZLW radio time signals was 0·03 seconds, and the maximum error during the year was 0·40 seconds. This error developed during a period of several days in December during which no overseas radio time signal checks were received. There was only one complete failure of the signals during the year, caused by a fault at the radio station. Partial failures occurred on eleven occasions, only three of which were due to faults in the Observatory.

Public Clocks.—The Government Buildings clock was checked daily and regulated when necessary. The maximum errors observed during the year were 27 seconds fast and 39 seconds slow. This is the only public clock whose timekeeping is controlled directly by the Observatory.

The synchronous electric clock was interrupted by weekly power cuts in May and June and by occasional power failures at various times during the year. The maximum errors observed were 11 seconds fast and 10 seconds slow.

Timepieces.—Three new quartz-crystal clocks from Dominion Physical Laboratory were installed for trial in September. The original prototype clock is to be taken to the Laboratory for modification. The trial period so far has been satisfactory, but the clocks are located temporarily in the clock room and are still dependent on mains power supply. It is expected that the battery power system will be completed early in 1953.

A local "Synchronome" time service is being installed to supply correct time automatically to the Meteorological Office, the Carter Observatory, and various parts of this observatory. Progress with this has been held up owing to staff difficulties and pressure of more urgent work.

A new marine chronometer for time service purposes was obtained from England.

During the year several chronometers and watches were rated for the Royal New Zealand Air Force, Island Territories Department, and New Zealand Fisheries, Ltd.

Emergency Power Supply.—In order to overcome the difficulty in carrying on time service work during power cuts, arrangements were made for this Observatory to be connected to the Meteorological Office emergency power supply.

General

Information.—In addition to the regular bulletins and reports, information relating to earthquakes and time service matters was supplied to the Earthquake and War Damage Commission, the press, and the general public. A considerable amount of work was involved in supplying data from earthquake records to overseas investigators. A number of original seismograms were sent on loan to persons or institutions overseas for special studies.

Publications.—Owing to the volume of routine work it has been impossible to keep the publication of seismic bulletins up to date.

Visitors.—In addition to a large number of casual visitors, several parties of school children visited the Observatory during the year under arrangements made by the Junior Chamber of Commerce.

OCEANOGRAPHIC OBSERVATORY

Director: Vacant

Mr W. M. Jones, Director of the Observatory since its establishment, died on 15 March 1953.

Defence Oceanography.—Attention has been directed to the needs of defence oceanography in New Zealand.

Hydrology.—Studies have continued on the distribution of temperature and salinity in waters of the south-west Pacific and Tasman Sea. Observations from 1949 to the end of 1952 are being interpreted and prepared for publication. The collection of temperature observations, thermograph records, and water samples for salinity determinations has been continued.

Wave Studies.—Studies of the Greymouth wave records in relation to meteorological conditions have been concluded. A statistical study of the distribution of wave height in the Greymouth wave records has been made.

Work is advanced on theoretical aspects of the distribution of height and period in ocean waves in terms of the underlying spectrum, and new techniques have been established for the analysis of wave records.

Marine Fouling.—A marine biologist joined the staff during the year and two projects are in hand: a survey of the incidence of marine fouling on local and overseas vessels; and experimental immersion tests at main New Zealand ports to establish the identities of the dominant fouling organisms, their seasonal periods of attachment, growth rates, and fouling sequences.

Marine Geology.—Through the co-operation of naval and merchant vessels, many echo sounding records in New Zealand waters and in the South-west Pacific were secured. A bathymetric chart covering this area is in preparation and detailed studies of the submarine topography of Cook Strait, Bay of Plenty, and Milford Sound are in progress.

An investigation of rate of sedimentation in Wellington Harbour has been completed.

Surface-current Observations.—An investigation of surface currents in the South-west Pacific using drift cards has been planned. Naval and merchant vessels are co-operating in the project.

Publications.—One paper was published during the year, and others are in the course of preparation.

GRASSLANDS DIVISION

Director: Dr J. Melville

PASTURE GROWTH AND SOIL FERTILITY

The regenerative power of pastures on land depleted by cropping has been known for centuries. Previous annual reports have given brief details of trials started in 1946 at Palmerston North, and later at Lincoln and Gore Substations, in which the effects of clovers, of lime and superphosphate, and of the grazing animal were separately determined in the fertility-building process. The criteria of improvement were the yields of pasture herbage, the levels of certain essential mineral elements in the soil, and the yields of rape and maize crops sown after the pasture trial was completed.

In the Palmerston North trial big differences in pasture yields were apparent after the trial had been in progress for six months. By the end of two years a clear pattern of production for the various treatments was established and remained relatively unchanged throughout the trial. Where grass was grown in the absence of clover, the pasture rapidly deteriorated to browntop dominance and production stabilized at less than 2,000 lb. D.M. (dry matter) per acre per year. No improvement in yield was obtained from generous application of lime or superphosphate, and subsidiary trials showed that nitrogen was the primary limiting factor.

The incorporation of clover in the seeds mixture led to marked gains in total production, and annual yields up to 11,000 lb. D.M. per acre were obtained by the end of the second year. The increase over the all-grass treatment was due not only to clover herbage, but also to the threefold increase in grass growth resulting from its association with clover. Where adequate superphosphate was applied, this yield was maintained throughout the trial and the association was dominated by white clover and ryegrass in that order. Where superphosphate was not applied, yields steadily decreased over the last three seasons to about 8,500 lb. D.M. White clover decreased and red clover increased in relative importance until in the final year the yields of the two clovers were practically equal. This was the only treatment in which red clover contributed significantly to yield in the later years of the trial, and subsidiary investigations indicated that the decline in white clover (with concurrent proportional increase in red) was linked with sulphur deficiency. In other words, superphosphate in this particular trial appeared to be of greater value for its sulphate than for its phosphate content.

The application of dung and urine, in proportion to herbage yield, to the above treatments brought the annual yield up to an average of 14,000 lb. D.M. per acre, the gain being thus considerably less spectacular than that brought about by the inclusion of clovers in an all-grass sward. A marked change in botanical composition occurred, however, the association settling down rapidly to ryegrass and white-clover dominance. Cocksfoot was the only other species that contributed significantly to yield in the later years of the trial.

Of equal importance was the finding that neither superphosphate nor lime caused increases in yield or changes in botanical composition on the grass-clover pastures to which dung and urine were applied. It may be concluded, therefore, that under our particular soil and climatic conditions, and using mature wethers as sources of dung and urine, the calcium, phosphorus, and sulphur cycles, through soil, plant, and grazing animal, were complete. There was nothing to indicate that this situation would have changed had the trial been continued indefinitely.

Throughout the trial, analyses for nitrogen, calcium, phosphorus, and potassium were made on three-monthly bulkings of grasses and clovers. The

results confirm the previous findings of the large quantities of mineral plant foods that are taken up from the soil by vigorous pastures, and of the large differences in leaf nitrogen levels that may be expected when grasses are grown in the presence and absence of clovers and of the grazing animal respectively.

Calcium and phosphorus showed seasonal variations of interest to the animal nutritionist. In both clovers and grasses, phosphorus concentration was low in summer and autumn when calcium levels were at a maximum, and the phenomenon was reversed in winter and spring. Since clover contains more than twice as much calcium as grass and since the clover content of summer and autumn pastures is much higher than in winter and spring, it is hardly surprising that the calcium to phosphorus ratio varies from 1·4 : 1 to 2·2 : 1. It is also important to note that in high-producing pasture associations the demand made by rye-grass on soil phosphate supplies is about three times as great as those made by clover.

The pasture aspect of the trial was concluded in the fourth and fifth years after establishment, when the area was ploughed and cultivated. Marked differences in soil texture and colour were obvious at this stage. The soil of the low-producing plot was grey to light brown in colour, showed a distinct glaze on the plough furrow, and was poor in texture. Colour and texture improved with increasing pasture yield, and the soil from the highest yielding pasture plot (grass-clover with return of dung and urine) was dark brown, and broke down rapidly with cultivation to give an excellent tilth. Crops of rape and maize were sown in the spring, and within two months marked differences in vigour and in leaf colour were apparent among the plots. At harvest the yields of both crops followed a very similar pattern to those of the pastures that were ploughed under. Rape growth on the cloverless plots was stunted and yellowish-green in colour, the D.M. yield being 3,000 lb.; growth on the highest yielding pasture plots was vigorous and dark green, with a yield of 8,500 lb. Similar results were obtained with maize, and the conclusion was inescapable that the productivity of the pasture was the governing factor in the vigour of the subsequent forage crop.

After harvesting and discarding the first crops following pasture, further seedings of other annual species were made over the next six to twelve months. The large differences in yield described above almost entirely disappeared in the second and subsequent crops, when all plots were uniformly poor. Hence in this experiment the fertility that had been built up by four years of high-production pasture was dissipated through the growth of the first forage crop.

In a trial such as this, where changes induced in any one member of the complex of soil, plant, and animal brings about corresponding changes in the other two, it is obvious that the observed differences as summarized above are the result of a host of factors. Nevertheless, it is possible to place many of these factors into some order of relative importance and the conclusion reached is that nitrogen is the key to the situation. It has already been pointed out that severe nitrogen deficiency was responsible for the poor yield of the all-grass plots. The inclusion of clover resulted in a spectacular increase in yield, the clover fixing sufficient nitrogen not only for its own requirements, but for those of greatly increased grass growth. Since this treatment was under mowing, with removal of clippings, the transfer of nitrogen from clover to grass must have occurred solely by underground transport. When the herbage was fed off to stock and the plant nutrients returned to the pasture as dung and urine, further increases in production occurred, and clover dominance changed to grass dominance. Again nitrogen was the major factor in bringing about the observed changes, and it is of interest that the highest yielding pastures showed no response to added nitrogen.

It is necessary to stress, in this consideration of nitrogen in relation to

soil fertility, the importance of pedigree strains of white clover in the achievement of maximum pasture yields. Trials over a number of years have shown conclusively the high efficiency of pedigree plants in comparison with those of uncertified origin.

Other factors, both nutritional and climatic, undoubtedly play an important role, but the evidence from this trial points to the conclusion that soil-fertility changes under pasture can be largely explained by changes in nitrogen status. This conclusion is supported both by soil analytical data and by the growth of subsequent forage crops. The observed differences in yield are paralleled by differences in protein content of the leaves and stems of the harvested crops, the maximum difference in uptake corresponding to 125 lb. nitrogen per acre (equivalent to 625 lb. sulphate of ammonia). Moreover, the lack of differences in yield of the second and subsequent forage crops was undoubtedly caused by the exhaustion of soil nitrogen supplies, primarily due to uptake by the first crop, and secondarily to leaching losses.

The results from the corresponding trial at Gore differ only in detail from those at Palmerston North, *e.g.*, superphosphate caused yield increases even when dung and urine were applied in proportion to yield. But again the dominating factor was the nitrogen status of the soil as affected by clover growth and by the grazing animal.

At Lincoln, under conditions of lower annual rainfall with pronounced summer drought, the process of fertility building is slower, and red clover assumes a position of considerably greater importance. It was obvious, however, that the same general principles apply under Canterbury conditions.

The results of the trial have direct bearing on farming practices in New Zealand. Where pasture has seriously deteriorated before being ploughed up, the taking of a summer or winter crop before sowing down again is of doubtful advantage. Only in exceptional circumstances will a satisfactory yield be obtained, and emphasis should be laid on increasing soil fertility as rapidly as possible. This will be achieved better by a programme of sowing direct to grass, with every effort being made to establish a high-producing pasture that will automatically increase soil fertility. A variant of this which may be useful in certain restricted cases is oversowing and top-dressing the run-out pasture so that fertility is restored without ploughing.

Conversely, the cashing in on fertility built up by high-production pasture is of great importance in achieving maximum production from New Zealand's arable land. Our ability to produce animal products cheaply and efficiently through pasture should not blind us to the other demands that are made on our ploughable soils. For example, New Zealand's wheat harvest for many years has been only a fraction of her requirements, and the potato crop has been insufficient to meet internal demand in two successive seasons. Human food crops form the ideal counterpart to high-production grassland, and the combination represents the most effective use of ploughable land. Not only is the farmer capitalizing on fertility built up through his pastures, but the production of a white crop brings the soil into better condition for sowing down new pastures. Many other factors, of course, enter into such a scheme of land use: the economics of white crop production, incidence of disease, labour supply, degree of subdivision, and a number of others, all of great importance. But none of these overrides the general conclusions reached above.

PASTURE ESTABLISHMENT

Trials have been continued both on fertile alluvial land at Palmerston North and on virgin pumice soils in the Rotorua-Taupo area.

On the former the problem is to maintain a balance between the initial heavy growth of short-rotation ryegrass and the much slower growth of other

grasses and the clovers. This is particularly difficult on soils of high nitrogen status (see preceding section), on land too wet to control by grazing during the first winter, and with heavy seedings of short-rotation ryegrass. Improved results have been obtained by lowering the seeding rate of the latter to 15 lb. or less, depleting soil nitrogen by means of a summer crop, and close control by grazing during the first four to six months. Weed control by pre-emergence spraying, and the incorporation in the seeds mixture of a forage cereal for quick leaf production, are also being investigated.

A field survey of new sowings on pumice land in 1948 showed high mortalities of white and subterranean clover seedlings, and a consequent delay in the development of high-production pastures. Glasshouse experiments with typical samples of pumice soil showed that there is an indigenous *Rhizobium* population, but field trials showed clearly that the great majority of infecting organisms were ineffective fixers of nitrogen. It was concluded that clover seedling mortality was closely linked with nitrogen starvation, the effect being most marked when associated grass seedlings competed strongly for the small soil reserves. Further experiments demonstrated that inoculation of clovers with effective strains of *Rhizobium* resulted in greater vigour and in lower seedling mortality.

This work on the nitrogen nutrition of clover seedlings on pumice was greatly extended in the past season by a series of glasshouse and field trials in which white, red, and subterranean clovers were used. The previous results were amply confirmed, and collaborative work with Plant Diseases Division has shown the variations in effectiveness of a number of *Rhizobium* strains.

Another aspect of the work has been the demonstration that placement of seed and fertilizer in drills that bury the seed at about 1 in. depth when covered resulted in better and more even emergence. A prototype roller drill was constructed in collaboration with Massey Agricultural College, and full-scale machines of the same type are now in use by contractors to the Lands and Survey Department. It is now reasonable to hope that the final result will be economy in seeding rate, economy in superphosphate at sowing, and a much quicker development to a high-production pasture. Large-scale trials in collaboration with the Lands and Survey Department, using standard contracting equipment, are now in progress.

PLANT BREEDING SECTION

Work is being continued with the ryegrasses, cocksfoot, timothy, white clover, and red clover.

Cocksfoot.—The cocksfoot strain produced at this Division has proved satisfactory in trials at the substations and in the field. The Department of Agriculture has now distributed seed for increase under the Government seed certification scheme. In comparison with the strains previously certified, this strain is more productive, has a wider seasonal spread of production, and recovers more rapidly after grazing or cutting.

Blind-seed Disease.—Work has been continued on various factors considered important in the problem of breeding a strain of ryegrass resistant to blind-seed disease. It was hoped that it might be possible to breed for escape from the disease by advancing or retarding the season of flowering of the strain so as to avoid the period of maximum ascospore production. Development of primary infection from ascospores, however, has been shown to be prolonged, at least in a season such as the last at Palmerston North when moist, cool conditions occurred over a long period during the summer. Infection from ascospores was obtained in the field continuously over a two and a half-month period. In such a season both early and late flowering strains would be subject to ascospore infection.

New Ryegrass Hybrids.—It is considered that hybridizing within the extremely variable ryegrass group still offers scope for the breeding of a new ryegrass strain that could fill a place in grassland farming not adequately filled by the certified strains of perennial, short-rotation, and Italian ryegrass. The first-generation hybrids between perennial and short-rotation ryegrass appear to be very promising for the production of a strain intermediate between these two. The best of these hybrids are being selected for further breeding work. A number of generations of selection and intercrossing will be necessary before a type is fixed and a new strain built up for field trials.

Certification.—Approximately 9,000 plot tests have been made on samples drawn from certified lines of seed. This year for the first time short-rotation ryegrass has been identified as a contaminant in a line of perennial ryegrass harvested by farmers.

In a study of the two main varieties of red clover (cowgrass and the late-flowering strain) under different lengths of day, significant differences between varieties have been obtained in such characters as leaf size, length of stem, and time of flowering. It is hoped that the information obtained from this experiment can be used in the designing of a more rapid test on red clovers harvested as certified seed.

Nucleus-seed Production.—The last two seasons have been unfavourable for locally grown seed crops, but from previously accumulated nucleus stocks and from the further increase at the Crop Research Division at Lincoln all demands for nucleus seeds have been supplied.

Strains Measurement Technique Trial.—In this experiment the use of a fertilizer mixture to replace dung and urine return to mown plots is being continued and is giving very satisfactory results.

PLANT CHEMISTRY SECTION

Apart from the plant chemistry and physiology investigations mentioned under the two main headings above, other investigations are in progress.

Nitrogen Metabolism and Protein Fractions of Pasture Plants.—Methods of extraction, fractionation, and purification of the soluble leaf proteins of grasses and clovers have been standardized. Pigmented compounds of high molecular weight follow the protein fractions closely, and hampered earlier attempts at characterization. Considerable progress has been made recently in purification procedures, and the preparation of relatively non-pigmented fractions is in sight.

Work is being continued on the determination of free amino-acids and peptides in various tissues and organs of pasture plants. The results of this study are being applied to rumen metabolism on the one hand and to the pattern of synthesis within the plant under different environmental conditions on the other.

Ruminant Digestion.—The object of this investigation is the correlation of the seasonable changes in chemical composition of pasture herbage with the biochemical processes that take place in the first stomach of ruminant animals. Particular attention is being paid to the soluble constituents, which are the first compounds to be fermented and which make up nearly 30 per cent of the total leaf weight.

During the year emphasis has been laid on the problem of bloat, which is of importance only in ruminant animals. It has been established that dry, stall-fed cattle can be used as test animals. Of the pure species and mixtures of species tested, red clover at all stages of growth was the most consistent producer of bloat, and a large area of this species has been sown down for further investigations this spring. The effect of wilting, drying, and freezing on bloat-producing herbage, and its fractionation in various ways, will be studied.

Seed Research.—The work on the relationship between relative humidity and moisture content of stored seeds is being continued, and its application to seed stores is receiving attention.

The tetrazolium staining method has been applied to the determination of viability of dormant Italian and short-rotation ryegrass seeds. The method gives a more reliable measure of the proportion of viable seeds than does the germination test for several months after the seed is harvested.

Plant Carbohydrates.—Although carbohydrates in the form of soluble sugars and of cell wall materials are quantitatively the most important group of substances in pasture herbage, it is only during the year under review that any systematic investigation has been possible. Again the results are of value to the studies both of rumen metabolism and of plant synthesis reactions.

PASTURE ECOLOGY SECTION

The work described in the first two sections of this report was primarily the responsibility of the Pasture Ecology Section.

Hill Country Pasture Improvement.—Results at Te Awa during the year have substantiated the previous findings that the introduction of the appropriate legumes, controlled grazing, and superphosphate application will result in high-production swards. Four ewes per acre were wintered last year, and it is proposed to increase the number to four and a half in the coming winter on the best treatments. Preliminary results from trials made by the Soil Conservation and Rivers Control Council indicate that high-production pastures increase the water infiltration rate and hence increase soil stability.

Farmlet Systems.—The 1 acre farmlets which have been under study for the past four years were changed over from wethers to ewes and lambs. High yields of good-quality lambs (nine per acre) were obtained in this first season, and it appears probable that even better results may be achieved in the coming year.

Bloat.—In addition to the biochemical approach to this problem mentioned above, work has been continued on the control of bloat through management. The results give support to the conclusions previously reported, viz., that intensive break-grazing of tall pastures (short-rotation ryegrass, white and red clovers) is a valuable control measure.

Physiological Studies.—The effects of changes in light intensity and temperature and of defoliation have been determined on various grass species. Thus far, only widely different environmental conditions have been imposed, but special growth cabinets in which more precise measurements can be made are now under construction.

Sulphur Nutrition of Pasture Plants.—Arising out of the findings that the calcium sulphate portion of superphosphate was of importance in maintaining vigorous white clover growth, new trials have been laid down to define the role of sulphur more accurately.

Greenkeeping Research.—Quantitative information on yield, botanical composition, turf mat formation, and soil acidity has been collected over a two-year period on the Hokowhitu plots. Owing to financial restrictions this work will not continue.

SUBSTATIONS

Although the provision of winter keep is always a limiting factor in Southland farming, high ewe-carrying capacities have been achieved on the farmlets at the Gore Substation.

The use of nitrogenous fertilizer for seed production in cocksfoot and timothy has proved of considerable value, but further work on times and rates of application is required. The effect of grazing cocksfoot seed producing areas is also being studied.

Trials to investigate the efficiency of different phosphatic fertilizers and the relation of lime and molybdenum are in progress on the Station and elsewhere in Southland. Complementary to this latter investigation is a series of lysimeter trials recently established.

RESEARCH EXTENSION

Seven hundred New Zealand and 200 overseas visitors were shown over the Station. Broadcast lectures and talks to farming groups were given by different members of staff.

PUBLICATIONS

During the year fifteen technical papers were published and twenty-five were accepted for publication.

HOP RESEARCH

Station Research Officer: Dr R. H. J. Roborgh

During the year hop research has been continued on a co-operative basis with the Cawthron Institute and with the Crop Research and Plant Diseases Divisions of D.S.I.R. The Institute is responsible for mycological and manurial trials, the Plant Diseases Division for quarantine, and the Crop Research Division for general guidance especially in the breeding work.

The Station now has an up-to-date hop kiln equipped with an automatic stoker and a power-operated hop press.

BREEDING

The three types of the Californian variety growing in the Station nurseries did not show differences in vegetative growth so clearly as during the previous season. By the end of the season, however, the previously observed differences in shape of hop cones again showed up very distinctly.

Surveys of hop gardens indicated that, apart from some seedling contamination, they are planted in the main with only five different hop varieties, viz., Californian, Fuggle, Bumford, Cluster, and Golding. The Californian variety covers about 95 per cent of the total hop-growing area. These varieties are all represented in the Station nurseries. Soil infection trials have shown that whereas the high-yielding Californian variety is very susceptible to black root-rot, the medium-yielding Fuggle variety is probably not susceptible under normal growing conditions. For this reason a first series of artificial pollinations, Californian (female) × Fuggle (male), has been made.

Some of the seedlings raised from imported seed of English hop varieties showed promising yields and qualities. They were generally higher in resins and thus higher in preservative value (P.V.) than the five local varieties. Some 80 of these seedlings have been tested for resistance to black root-rot. Further tests are required, but the work has shown the greater resistance of most English seedlings to the disease than the local types.

Imported cuttings of well-known English varieties which were planted under strict quarantine in the North Island in 1948 were transplanted to Nelson district at a safe distance from commercial gardens. They showed satisfactory growth for this first season, especially the Bullion variety.

DISEASES

Only two new outbreaks of *Phytophthora* have been found in commercial gardens, and in infected gardens the disease did not show up so abundantly as it did in the previous year.

Incurling of the leaf margins, known as "curly leaf," was again widespread. The cause of this disorder is still obscure, and investigations are continuing.

In a first-year garden at Rakau the serious disease verticillium-wilt has been found on hops for the first time in this country on a piece of land where potatoes were grown last season. From English experience it is possible that the disease was introduced into the garden in infected tubers. The infected part of the garden has been taken out and the hop plants destroyed.

The experimental plots for the control of black root-rot at the Hop Research Station have been extended to include tests of the value of sulphur, chlorobromopropene, and dithane. Observations made at the close of the 1952–53 season showed that no chemical treatment has proved completely effective in the control of the disease, one or more plants dying from black root-rot in every experimental treatment. Chloropicrin and calcium cyanamide so far appear to be more effective than D-D and capsine in controlling the disease. Further tests carried out on the grounds of the Institute showed that capsine, thymol, and Ferbam used as soil treatments failed to prevent infection of hop cuttings with black root-rot.

Tests of the apple strain of *Phytophthora* have been carried out on hop plants and inoculations of the hop strain of the fungus have been made on different varieties of apples. So far the available evidence does not suggest that the hop strain would readily infect apple trees or the apple strain readily infect hop plants.

GROWING CONDITIONS

Fertilizer trials in selected hop gardens have been continued and now give yield records from three gardens for four seasons and from three other gardens for two seasons. The treatments, consisting of 5, 10, and 15 cwt. of a standard fertilizer and 10 cwt. of a widely used hop manure per acre, all with a top-dressing of sulphate of ammonia of 1 cwt. per acre in December, were the same for each season. In five gardens out of six the 10 cwt. application has given a substantial increase in yield over the 5 cwt., but the yields from the 15 cwt. application, although greater on the average, showed more variation than from the 10 cwt. application. The average yield from the 10 cwt. hop manure was approximately the same as that from the 10 cwt. standard fertilizer.

Observations have been continued on the experimental plots set out in previous seasons. Further plots have been established to compare the relative values of borax and pandermite (a calcium borate) for the control of boron deficiency. Showery weather throughout November and December was not favourable for the occurrence of the deficiency in hops, but nevertheless symptoms were observed in a few gardens.

During the past two seasons symptoms of magnesium deficiency have been noted in hops grown on granite soils or on those derived from the Moutere Gravel formation. Plots were established several seasons ago in which magnesite at the rate of 1 lb. per hill, either alone or in conjunction with borax, was used. Further plots were set out in the spring, 1952, to test the relative value of magnesite and dolomite in controlling the deficiency in selected hop gardens. Analytical data for plant material from the original plots have shown that only on light sandy soils derived from granite has there been any increase in magnesia content of leaves and cones. So far the effect of magnesite on the growth of hops has been slight.

At the Hop Research Station a 3½-acre garden has been erected to find out the influence of the height of the wire-work (14 ft., 16 ft., and 18 ft.)

and spacing of the hills (6 ft. × 6 ft. 6 in., 7 ft. 6 in. × 6 ft. 6 in., and 9 ft. × 6 ft. 6 in.) on the development of types A and B of the Californian variety.

INFORMATION BUREAU

Officer in Charge: Mr N. A. Marris

PUBLICATIONS

New Zealand Journal of Science and Technology.—Prompt publication of both sections of the *Journal* has continued during the year, and generally each issue has appeared on the first day of the month of issue. The backlog of articles which earlier remained in the Agricultural Research Section has been overtaken.

The number of manuscripts accepted for publication in the Agricultural Research Section has been well maintained and that for the General Research Section has considerably increased. The standard required for acceptance for publication has been kept up. Subscription rates were increased in view of increased printing costs.

The tentative standards previously drawn up for use in preparing material for publication have been revised and enlarged in the light of experience and of comments received from Branches of the Department. The revised standards have been issued in cyclostyled form as Notes for Contributors. These notes serve as a guide to the editorial staff and to the editorial committees that have been set up in certain Branches of the Department, and they also provide valuable assistance to individual contributors.

Bulletins.—Bulletins published during the year have included: Apia Observatory Magnetic and Meteorological Results for 1949; Amberley Magnetic Results, 1949; Amberley Magnetic Results, 1950; "Magnetic Re-survey of New Zealand, Epoch 1st July, 1945", by H. F. Baird and A. L. Cullington; Seismological Reports E 118, E 119, E 120; Radio Research Office Bulletins RRO 41, 42, 43; D.S.I.R. Bulletin 102, "A Revision of the Melolonthinae of New Zealand", by B. B. Given and J. M. Hoy; D.S.I.R. Bulletin 105, "List of New Zealand Polychaetes", based on MS. of the late Sir William Benham; D.S.I.R. Bulletin 106, "Aphids of New Zealand", by W. Cottier; D.S.I.R. Information Series No. 5, "Arable Farm Crops of New Zealand", by J. W. Hadfield; Paleontological Bulletin 19, "Permian Fossils from Southland" by H. O. Fletcher, Dorothy Hill, and R. W. Willett; Paleontological Bulletin 20, "Early Tertiary Penguins of New Zealand", by B. J. Marples, with appendix by H. J. Finlay; Departmental Handbook, "The New Zealand Department of Scientific and Industrial Research"; Botany Division, "Index Seminum"; and Reprint of Paleontological Bulletin 17, "Additional Lower Pliocene Mollusca from Otahuhu, Auckland", by C. R. Laws.

CENTRAL LIBRARY

The amount allocated to the Department for expenditure on books and periodicals was severely reduced during the year. Limitation of supplies of standard publications involves increased lending and circulation of those held, which is not satisfactory for either borrower or lender.

New technical books and journals are not coming into the country as fast as is desirable, and specialist laboratories that should hold fairly complete collections of relevant literature on a national basis are unable to do so.

Except in the circulation of journals, which continue to grow, there was little increase in the amount of work handled. During the year a valuable collection of French scientific books was generously presented to the Department by the Minister for France.

At the end of the year, work was considerably disorganized for a time owing to the loss of senior graduate staff. It is difficult to hold graduate staff with the present low salary maximum.

TECHNICAL INFORMATION SECTION

Advisory Service.—This Section dealt with some 500 major inquiries during the year. Approximately half of these were from manufacturers, and over one-third were from Government Departments and local authorities. Over 90 letters of appreciation show that the service is of value in industrial and official circles. The Technical Information Officer keeps in close touch with the professional staff and with the Scientific Liaison Offices in London and Washington. Collaboration with various information agencies, the technical staffs of private firms, and other organizations has been considerably extended. Most of the more important inquiries were answered by individual letter, but frequently recurring questions were answered by circulars prepared by various Branches of the Department or by the Technical Information Officer. During the year a number of visitors were received and were supplied with the information they sought.

The *Industrial Bulletin* is published jointly by this Department and the Department of Industries and Commerce, but contributions have been received from other Departments. This Department's section of the Bulletin has specialized, in certain issues, in subjects of current importance, viz., health, safety, the food industry, insecticides and fungicides, building, ceramics, and electroplating. Requests for originals of abstracts published numbered 183.

Abstracts.—Approximately 250 abstracts of scientific and technical articles were prepared during the year for publication in the *Industrial Bulletin,* partly with the help of the Department's Translator.

Photo-copy Service.—Over 6,000 pages were copied to meet requests from departmental officers and others.

TRANSLATION SECTION

The aim of the Translation Section, established last year, has been to make the foreign literature of science as freely available as possible to those in the Department who need it. The methods employed have included (1) the supplying of skeleton translations as a guide to the scope of an article, (2) the preparation of abstract translations as an indication of contents and results, (3) the making of selective translations in which a given work is searched for references to a particular subject, and (4) the giving of oral translations in consultation with the research workers concerned—this is the most expeditious method. These abbreviated treatments serve to determine whether a full and exact translation of a part or the whole of an article is called for. A wide coverage of the literature could not be effected if a full translation were made of all the articles submitted. The rapidly increasing demands made on the Section have made it necessary to adopt a system of this nature.

The demand during the year for translations from modern European languages, on a percentage basis, was: German 58, Russian 12, Swedish 8, French 7, Danish 6, Italian 5, Dutch 2, Spanish 1, and four others collectively 1. It is to be noted, however, that departmental officers translate nearly all of the French they require, some of the German, and all of the Latin used in taxonomic botany.

PUBLIC RELATIONS

Press Publicity.—The issue of information to the press has, as previously, been carried out mainly by the frequent issue of press releases, and by the

arranging of interviews by press representatives, the answering of inquiries, and the supplying of information for special articles, etc.

General.—A reference book summarizing the main activities of each Branch, and giving other general information on the Department, was compiled by this section, and this—the first issue—was widely distributed. The handbook was everywhere well received, and was given many appreciative press notices.

The work of this section has, as usual, included the arranging of broadcast talks, film screenings, press-clipping distribution, the compilation of the Department's annual report, and assistance on publications.

PHOTOGRAPHIC SECTION

In addition to the routine photographic work undertaken for branches by this section, e.g., photocopying, preparation of lantern slides, and film and print processing, the following special work was completed during the year.

For the Geophysics Division a 400 ft. 16 mm. silent cine film was made of the "Crustal Structure Project". This film is proving useful for lecture purposes, etc. Many still photographs taken at the same time are used for reference purposes.

For the Entomological Research Station a series of close-up colour photographs was made of the pasture-killing grubs. These colour slides are screened in conjunction with lectures to farmers. Many photographs were taken of experiments to determine the effect of various dosages of insecticides on germinating seedlings of wheat, oats, clover, and pasture grasses.

For the Animal Ecology Section, both cine and still photographs were taken at the Rabbit Research Station at Gwavas in which long-lens techniques for photographing rabbits in their natural environment were used.

For the Geological Survey a large number of inch-to-mile maps were photographed and enlarged to 4 in. to the mile in order to enable officers to record their findings in greater detail.

For the Soil Bureau, maps were photographed and reduced to precise sizes for publication.

For the Botany Division a series of colour photographs was made of New Zealand native plants. Throughout the year many botanical specimens were photographed.

OCCUPATIONAL PSYCHOLOGY RESEARCH SECTION

Officer in Charge: Mr Dermot Straker

Industry.—At the request of two firms with world-wide coverage, a group-selection procedure for graduate candidates for executive traineeships was devised. This is believed to have been the first application to New Zealand industry of the officer-selection procedures that were developed during the late war by the British Services.

The Section played an active part in the Advanced Personnel Management Course conducted by the New Zealand Institute of Management. This body, in conjunction with the New Zealand Institute of Public Administration, organized an Executive Management Course for senior officers from industry and the public service, for which the Section acted as consultants.

National Airways Corporation was assisted in the design of a traffic control board showing the state of booking on all flights for a two-monthly period. With the co-operation of the paint section of the Dominion Laboratory, a set of symbols in black and yellow was designed. These can be discriminated easily at the required distances, and should avoid risk of confusion by staff with imperfect colour vision.

University.—The collection of data concerning the progress of science degree students in the University of New Zealand was completed, and the data are now being analysed by the Applied Mathematics Laboratory.

Defence Science.—In addition to providing members for various officer and apprenticeship selection boards, the Section has acted as consultant to the personnel branches of the three Services.

The officer in charge attended the conference of the Commonwealth Advisory Committee on Defence Science, held in New Delhi during March 1953. He was also the New Zealand delegate to a preliminary conference of Service psychologists. These conferences, together with visits paid subsequently to Service organizations, Government Departments, and universities in Singapore and Australia, provided opportunity for making a large number of useful contacts, which should facilitate the exchange of information with psychological groups in other parts of the Commonwealth.

Information Services.—The Section's library has again been in frequent use by personnel officers from industry, public servants, and students. Numerous inquiries from industrial and commercial firms and Government Departments on matters concerning staff welfare have been answered.

A cyclostyled report entitled "A Pilot Survey of Labour Turnover and Stability" was published during the year.

PLANT DISEASES DIVISION

Director: Dr G. H. Cunningham

Advisory services to other Government Departments, industry, and the public continue to expand. During the past year over 1,300 plant specimens, compared with approximately 1,100 for the previous year, were examined, and advice given on identity and control of pests and diseases present.

The Division has been able to make limited quarantine facilities available at its Owairaka Laboratory, and material of seven plant introductions is at present being grown under quarantine. Space for this work has been made available only at the expense of research work; moreover, this space is quite inadequate and it has been necessary to postpone a number of plant introductions until proper facilities can be provided by the establishment of a quarantine station at Otara. Four new fungous diseases and thirty-six additional hosts have been recorded during the year.

Two certification lists, containing many new products, have been issued during the year. Lucerne nodule culture sufficient to treat 380,675 lb. of seed was distributed to 2,502 farmers.

During the year, 850 collections of fungi were added to the herbarium, bringing the total number of collections filed up to 11,976; and 350 duplicate collections were forwarded on request to herbaria in England and Canada. A new host index to the collections was prepared.

ENTOMOLOGICAL INVESTIGATIONS

Citrus Thrips.—A survey of thrips occurring on citrus in the main citrus areas has shown six species to be present. Two species were common in all districts and were responsible for most of the russetting of fruit and silvering of leaves. Experiments on control are being carried out.

Leaf Rollers.—A survey of leaf rollers on pip and stone fruits and other plants has been completed. Over 400 specimens were collected, and from these 150 adults were bred out and mounted. A systematic study of the specimens is in progress.

Red Spider Mites on Grape Vines.—A survey has shown that two species are present, one being widely distributed and the other confined to the Auckland Province.

Resistance of Plants to Insect Attack.—Following demonstrations that certain swede varieties are more resistant than others to aphid attack, work has been continued to determine the chemical constituents of swedes and the nutritional requirements of the aphids. Investigations, in which paper chromatography and ion-exchange resins were used, have led to the identification of thirteen amino acids, two amides, and four sugars in swede leaves, and of ten amino acids, two amides, and two sugars in honey dew of the aphids.

Eriophyid Mites on Tomato.—A systematic study of the *Eriophyidae* occurring on tomato plants has been completed. This has involved examination of collections from both New Zealand and overseas.

Carrot Rust Fly.—Surveys have shown that carrot rust fly is the most serious pest of carrots in the Auckland, Hawke's Bay, and Taranaki Provinces. The biology of the insect is being further investigated, emphasis being placed on gaining knowledge of its habits in the field. Information already gained on incidence within fields and carrot-growing areas, on carry-over of the insect, and on the host-range of adults and larvae indicates that accurate knowledge of the habits of the pest is essential for formulation of successful control measures.

Green Vegetable Bug.—Studies on life history, field biology, and plant damage have been completed. It is found that up to three generations may occur in one year. In Auckland, bugs do not build up to sufficient numbers to be regarded as pests until the end of February or March.

Leaf Miners.—Further studies with oak-leaf miner have shown that it attacks a wide range of introduced and native trees. Biology of this insect is being studied as a preliminary to investigation of control measures.

During the year azalea-leaf miner was noted in New Zealand for the first time.

Tropical Rat Mite.—This mite has been found attacking man in New Zealand.

European Wasp.—Investigations into biology and control were terminated during the year. A full report on all work carried out has been completed, and will be prepared for publication in the near future.

MYCOLOGICAL INVESTIGATIONS

Bean-rust.—Further work with this disease has shown that it is prevalent in the Auckland area, and that it causes considerable reduction in yield in some late bean crops. Of 44 varieties tested for resistance, 1 proved to be highly resistant and 2 to be resistant. All other varieties were highly susceptible.

Silver-leaf of Fruit Trees.—In a search for a suitable method of control of silver-leaf, various materials have been tested by the trunk and branch injection technique.

Cypress-canker.—Recent reports and surveys have shown that this disease is seriously affecting many of the *Lawsoniana* hedges in the Waikato area. Infection has also been found in young trees in nurseries. In addition to the main host, *Cupressus lawsoniana,* the disease has been found on fourteen related species and varieties. *C. benthami* and some other species show a promising degree of resistance.

Collar-rot of Apples.—In further rootstock resistance trials carried out in collaboration with Fruit Research Station it has been shown that several rootstocks show a considerable degree of resistance.

Red-thread Disease of Lawns.—In experiments on control of red-thread some of the newer fungicides were compared with the standard mercuric-chloride

treatment. Several of these new therapeutants were as effective as mercuric chloride, are simpler to apply, and are less dangerous to handle.

Diseases of Linseed and Linen Flax.—In continuation of the work on rust, two new races have been discovered. The presence of these in New Zealand will materially influence breeding of linseed and linen flax for rust resistance. Further trials on resistance showed that of the additional 48 varieties of linseed and 48 varieties of linen flax, 11 of the former and 3 of the latter were resistant to the races present in New Zealand. Trials with weedkillers to destroy wild linen flax, which acts as an alternative host of rust, showed that several hormone weedkillers gave effective control.

Glasshouse and field trials on resistance of linseed and linen-flax varieties to pasmo showed that none of over 100 varieties tested was resistant. Several varieties, however, were tolerant to the disease.

In a field trial involving over 100 linseed varieties it was shown that 7 varieties were highly resistant to browning disease.

A limited survey of crops in North and Mid-Canterbury showed: pasmo occurred in epiphytotic form and caused severe reductions of yield; browning was present in many Kato crops, but was no more extensive than usual; and little rust occurred except on late-sown crops, where infection was severe.

Diseases of Peas.—A limited survey in Canterbury showed that collar-rot and downy-mildew were the most widespread diseases. Four new records of pea-wilt were made.

Investigation of techniques for inoculation with collar-rot showed that successful inoculation could be obtained by pre-soaking pea seed in spore suspensions of *Ascochyta pisi* or by spraying plants in the field with spore suspensions of both *A. pisi* and *Mycosphaerella pinodes.*

Diseases of Brassicas.—A survey of 100 swede and turnip crops in South Otago and Southland showed that 24 per cent of crops were infected with club-root and 84 per cent with dry rot. Aphis damage occurred in 19 crops, and mosaic was present in 3 crops on the Taieri.

Fifty varieties of swedes were tested in glasshouse and field trials for resistance to dry-rot. Several varieties showed some degree of resistance. Glasshouse trials with a similar number of turnip varieties showed that, although there was little difference in varietal susceptibility, turnips were in general more resistant to infection than swedes.

Cereal Diseases.—In collaboration with members of the Crop Research Division and the Department of Agriculture, two surveys of wheat crops were made. It was concluded that serious reductions in yield were caused by abnormal weather aggravated by widespread and severe septoria-blotch infection on leaves, straw, and ears, and to a lesser extent by brown foot-rot and powdery-mildew. Other diseases such as take-all and eye-spot were not more widespread than in a normal season.

A survey of the physiological races of wheat powdery-mildew showed that at least six races were present in New Zealand, and that all were fairly widespread. This work is a necessary preliminary to the initiation of a breeding programme for resistance of wheat to this disease.

Extensive field collections of crown-rust of oats were made in Canterbury and Otago. Material collected was used in resistance trials with 169 varieties and numbered lines of the Crop Research Division oat collection. Twelve varieties showed high seedling-resistance and 14 varieties high adult-plant resistance.

A screening trial to determine the relative susceptibility of 100 wheat varieties and species to eye-spot indicated that a number of strong-strawed varieties were more tolerant to infection than those at present in commercial use.

Following an outbreak of leaf-rust in rye-corn experimental plots, a small variety trial was carried out to determine differences in susceptibility of available varieties. Two varieties were resistant.

Onion White-rot.—In glasshouse trials a number of onion varieties resistant to white-rot under English conditions were much more resistant than Pukekohe Long Keeper, but in the field only two varieties showed promising resistance.

Seed Studies.—Preliminary trials in which hot carbon tetrachloride steep for seed-borne disease control was used have been carried out. To date, temperatures up to 145° F. and a steep of fifteen minutes have not depressed the germination of peas, linseed, and brassica seeds.

BACTERIOLOGICAL INVESTIGATIONS

Crown-gall.—The possibility of preventing gall formation by steeping plants in a suitable therapeutant was investigated. Of a number of materials used, only one prevented gall formation without damaging plants. In experiments carried out to ascertain the effect of soil pH on gall formation, no significant differences were obtained.

Walnut-blight.—Trials with Bordeaux mixture at different concentrations applied at different times, particularly during the flowering period, failed to control the disease.

Soft-rot of Swedes.—In continuation of work with soft-rot it was shown that the disease was serious only when plants were mechanically damaged. In a small pot trial two swede varieties were shown to be resistant to soft-rot infection following aphid infestation, whereas other varieties were susceptible.

Bacterial Disease of Potatoes.—A bacterial disease causing serious losses of potatoes in South Canterbury has been investigated. Isolations were made, and the organism obtained is being studied in order to identify it.

Tomato-canker.—A number of therapeutants were used in a field trial in an endeavour to control tomato-canker. One material gave promising results.

Stone-fruit-blast.—Experiments carried out in Central Otago have shown that infection can take place during at least nine months of the year. A technique has been developed whereby peach seedlings can consistently be infected with stone-fruit-blast under Auckland conditions, and this will enable experiments on control to be carried out. In screening trials with twenty-three therapeutants and six antibiotic substances, one antibiotic was found to give promising control without causing damage to plants.

Legume Nodule Bacteria.—Non-growth of clovers in some soils has been investigated in the laboratory by testing the effect of different chemicals on growth of nodule bacteria in the problem soil. Fifty-six chemicals have been used, and results have been determined by direct microscopic counts. A number of elements consistently brought about an increase in rate of growth of bacteria. Results have not yet been applied to trials with clover plants.

The work on use of strains of clover nodule bacteria in some of our problem soils has been diverted to a study of the immediate problem in Taupo pumice soils. Glasshouse trials with Wairakei pumice showed extreme differences in efficiency of strains. In the autumn of 1952 in the Wairakei area three small unfenced trials were laid down by the Department of Agriculture using three strains of culture for red, white, and subterranean clover. In the spring of 1952, in collaboration with the " Committee for Correlation of Experimental Work on Pumice Soils " and the Grasslands Division, further small plot trials were sown at Wairakei. Both trials showed the outstanding effect of selected strains of nodule organisms on establishment of clovers—particularly white clover—on pumice soils. Trials have been extended, in conjunction with the Department of Agriculture, to full-scale field trials. The results obtained

at Wairakei have confirmed the glasshouse work carried out in Auckland, and a similar approach is now being made to the study of several selected problem soils in other areas.

VIRUS INVESTIGATIONS

Chemotherapy of Viruses.—In continuation of this work it has been shown that infection with certain viruses can be prevented or delayed by application of dilute solutions of a substituted purine. The compound does not inactivate the viruses *in vitro,* but prevents multiplication of the virus within plant tissues. Interesting information has been gained concerning its mode of action. This work is now being carried out by a member of the Division temporarily stationed at the Molteno Institute, Cambridge, the necessary virus material being prepared at this Division and flown to England.

Lettuce Big-vein.—Field surveys have shown that lettuce big-vein occurs only in winter and early spring crops. Trials on resistance showed that there were considerable differences in varietal susceptibility to the disease.

Strawberry Viruses.—On behalf of the Department of Agriculture, stocks of the variety Auchincruive Climax were tested for virus infection.

Raspberry Viruses.—Testing of the Department of Agriculture's collection of raspberry varieties was continued. So far, 21 lines of 15 varieties have been tested and evidence obtained that 5 lines were infected, 4 varieties being involved. Results obtained in these trials suggest that three raspberry viruses occur in New Zealand.

MICROBIOLOGICAL INVESTIGATIONS

Industrial Microbiology.—Preliminary investigation of deterioration of lemons in store has been completed. A report with recommendations has been made to the Marketing Department.

Contamination of tanning liquor by *Mycoderma* species was investigated. Control measures were devised and are being tested on a commercial scale.

In a shipment of chilled beef to the United Kingdom an estimation was made of the contamination occurring in the storage chambers.

Spoilage of process cheese by gas-producing *Clostridia* was investigated and control measures suggested.

Following the successful formulation of measures for control of moulds on cork inserts of crown tops, five firms handling medicinal or food supplies have presented problems of moulds on cork surfaces. In each case a treatment has been evolved to suit the particular conditions.

Losses resulting from inadequate sterilization of tomato products were investigated.

Antibiotics.—Pilot-plant fermentations were carried out to provide material for pharmacological tests of the antibiotic 265 which was developed in this laboratory. This antibiotic has a broad spectrum, but in a partly purified state was shown to be toxic to animals. *In vitro* it was active against a number of bacterial plant pathogens.

Antibiotics and Plant Diseases.—A number of antibiotics were tested against a range of bacteria and fungi causing plant disease in New Zealand. Antibiotics tested included all those commercially available, together with some produced in this laboratory and a number received from overseas research institutions. Some promising results have been obtained.

TIMBER PRESERVATION INVESTIGATIONS

Toxicity Testing.—Toxicity tests of the two wood preservatives "Celcure" and "Boliden Salts" against the common house borer were set up during the 1952–53 flight season.

Treatment of Timber with Boric Acid by Diffusion.—A simple modification of the diffusion process was developed during the year. The method, which has been called "momentary-dip diffusion treatment," consists of passing green sawn timber through a bath or spray of concentrated boric acid/borax solution and then holding the timber in block stacks for a specified period. The method is being tested on a semi-commercial scale.

Specific gravity/temperature/concentration curves of boric acid/borax solutions were determined. These curves will greatly simplify processing control when the momentary-dip diffusion treatment comes into commercial use.

Findings of the Committee of Inquiry Into the Treatment of Timber by the Borax/Boric Acid Process.—The Committee accepted the results of the Division's work, and recommended borax/boric acid for treatment of building timber used under cover for prevention of attack by wood-destroying insects and fungi.

PLANT THERAPEUTANT INVESTIGATIONS

Insecticide Studies.—Good control of woolly aphis on apples was obtained with BHC, but, in general, some tainting resulted from applications made later than December. Schradan compounds and Midol also gave satisfactory control.

Lead arsenate was generally as effective in control of codling moth of apples as DDT or parathion.

Of a number of newer insecticides tested for control of red mite on apples, 4-chlorophenyl 4-chlorobenzenesulphonate was the most effective, giving as good control as summer oil but without causing defoliation.

In experiments in control of leaf roller on apples, six or eight applications of lead arsenate or eight applications of parathion emulsion gave adequate control.

Inclusion of DDT in two applications with lead arsenate sprays was more effective than lead arsenate alone in control of leaf-hopper on apples.

Three applications of DDT gave satisfactory control of mealy-bug on pears.

Applications of parathion emulsion in October and November gave good control of mealy plum-aphis.

Good control of thrips on citrus was obtained by heavy applications of DDT.

DDT emulsion applied at ten-day intervals proved highly effective in control of thrips on onions when applications commenced early in the season. Organophosphorus compounds were not as effective as DDT.

Ethylene dibromide applications to soil gave satisfactory control of eelworm on tomatoes.

In screening tests of insecticides for control of green vegetable-bug, HETP gave best control. BHC also gave promising results.

Tests of therapeutants for control of Mediterranean flour-moth in stored pea seed showed that fumigation with chloropicrin gave excellent control of the insect but reduced germination of seed.

Fungicide Studies.—In experiments on control of black-spot of apples it was shown that Bordeaux mixture followed by sulphurs up to four weeks after petal fall were more important than later applications. Full spray programmes using phenyl mercury chloride (PMC), thiram, ferbam, SR-406, and glyoxalidine gave control similar to that obtained from Bordeaux mixture and sulphurs. Bordeaux mixture plus sulphurs gave as good control as heavy concentrations of PMC and PM ammonium lactate formulations, and better control than heavy concentrations of mercurated lead arsenate or light concentrations of PMC or PM ammonium lactate formulations.

For control of ripe-spot of apples, ziram was more effective than Bordeaux mixture and caused no damage. It was found that control was improved by applying an early spray in January in addition to the February or March applications.

Good control of black-spot on pears was obtained with Bordeaux mixture, ferbam, thiram, or PMC, but Bordeaux caused severe fruit russet.

In experiments on control of brown-rot on peaches it was found that spraying at three- or four-day intervals through the flowering period with dichloronaphthoquinone or thiram significantly reduced blossom-blight. Dichloronaphthoquinone or SR-406 in applications up to three days before harvest gave satisfactory control of fruit-rot, but dichloronaphthoquinone caused skin blotching. Thiram or sulphurs were not as effective in controlling fruit-rot as dichloronaphthoquinone or SR-406.

Good control of powdery-mildew on grapes was obtained by application of Bordeaux mixture or copper oxychloride followed by sulphurs and by salicylanilide and dichloronaphthoquinone.

Sulphurs and a number of the newer fungicides were effective in controlling French-bean-rust and broad-bean-rust. During a period favourable for heavy infection of tomatoes with late-blight, application of copper sprays at intervals of four and five days was necessary to obtain control. Addition of spray adhesives did not improve performance. Dithiocarbamates and SR-406 gave promising results.

In screening trials for control of botrytis on leaves and stems of tomatoes, thiram, ziram, and SR-406 gave good control without plant damage.

Satisfactory control of onion-mildew was obtained in seedbeds with applications at ten-day intervals of Bordeaux mixture, copper oxychloride, and dichloronaphthoquinone to which was added polyethylene polysulphide as an adhesive.

In experiments on control of onion-smut it was shown that seed treatment with thiram compounds at 50 per cent of seed weight gave results comparable with those obtained by the formalin drip treatment.

Compatibility of Spray Materials.—A series of tests with a wide range of spray mixtures was carried out on tomatoes, potatoes, beans, apples, peaches, pears, apricots, and citrus. From results obtained, charts have been prepared and published.

Therapeutant Appliances.—An injector for field fumigation, capable of accurate delivery of liquid fumigants, has been designed. The injector will treat one acre in two hours.

PUBLICATIONS

During the past year seventy-one articles, written by members of the staff, have appeared in eight different journals. A further twenty-six papers and one book are in press.

SCIENTIFIC LIAISON SERVICE

The relative isolation of New Zealand research workers from those in overseas countries necessitated the establishment in 1928 of a Scientific Liaison Office in London. At a later stage similar offices were established in Washington and Melbourne. The Liaison Officers have obtained a great deal of up-to-date scientific and technical information the use of which has greatly assisted research workers and the Department generally.

Advance information from other countries assists the Department in formulating and modifying its own research programmes and in avoiding duplication of the work undertaken elsewhere. The Liaison Officers have access to the results of a vast amount of research in progress, much of which is on a scale beyond the normal resources of smaller organizations. In addition, Liaison Officers provide answers to specific technical inquiries from New Zealand, maintain and establish contacts with appropriate overseas research

organizations, obtain scientific reports and publications not otherwise readily available, represent the Dominion on specialist committees, assist scientific visitors from New Zealand, and act in an advisory capacity to other New Zealand official representatives overseas.

The Department is greatly indebted to research organizations overseas for their helpfulness to our Scientific Liaison Officers.

In both London and Washington the association of the Department's Scientific Liaison Office with the British Commonwealth of Nations Scientific Offices (B.C.S.O.) has greatly facilitated co-operation in scientific matters on a Commonwealth basis.

London.—The office, which has continued to operate as a unit of the British Commonwealth Scientific Office, was below strength until November, when the Scientific Liaison Officer in North America joined the staff.

The Scientific Adviser was appointed Chairman of the Executive Council of the Commonwealth Agricultural Bureaux in January. The extra work involved would not have been possible had the scientific staff not been back to strength.

The Scientific Adviser has attended meetings of the Commonwealth Advisory Committee on Defence Science, and many meetings of the International Standards Organization. The latest committee of the latter is one connected with standardization of pest-control chemical names.

The Scientific Adviser attended the following international meetings: the Third International Symposium on Chemistry of Cement, the International Society of Soil Science Conference, the International Council of Scientific Unions, the Symposium on Mineral Dressing, the UNESCO General Conference, and the Commonwealth Advisory Committee on Defence Science.

The office continued to give oversight to New Zealand National Research scholars in the United Kingdom.

Among projects undertaken by the office have been the following: (1) arranging the details of an examination of an experimental shipment of chilled beef and collecting reports thereon; (2) taking part in discussions on the use of geothermal steam in New Zealand; (3) continuing to act as the agent for obtaining supplies of radioactive isotopes for numerous workers in New Zealand; (4) investigating the use of gypsum as a building material (both the manufacturing and the building aspects have been investigated and would appear to have application in New Zealand); (5) answering numerous industrial problems forwarded from New Zealand; and (6) attending appropriate meetings and conferences of various learned and professional societies in addition to regular attendance at meetings of some seventeen committees on which the office is represented.

Washington.—The Liaison Officer attended and reported on several scientific conferences and visited various research institutions in the United States and Canada in the past year. These included the Annual Conference of the American Institute of Corrosion Engineers, the American Power Conference, the Canadian Gas Association Meeting, the American Chemical Society Meeting, the Canadian Royal Society Meeting, the Conference on the Origin and Constitution of Coal, the Atlantic Biological Station at St. Andrews, New Brunswick, and the Naval Research Establishment, Halifax, N.S.

The Liaison Officer served as an alternate delegate on the Sulphur Committee of the International Materials Conference held in Washington during most of 1952, and reported on recent advances that might be of assistance to New Zealand in alleviating the sulphur shortage.

Other activities included a report on research in Canadian universities; the procurement of a large volume of technical reports; keeping abreast of legislation dealing with scientific institutions and research, in particular the use of

chemicals in food; and evaluating public and private experiments in artificial rain making.

The transfer of the Liaison Officer to London during the year curtailed most of the scientific liaison activity of the office. The office is now engaged chiefly in the acquisition of publications and the handling of correspondence of a general nature, procurement of chemicals and equipment, and handling certain straightforward scientific inquiries from New Zealand.

Melbourne.—The Department's Scientific Liaison Office in Melbourne, established some ten years ago, was closed down during the year. In the earlier part of the year the Liaison Officer obtained scientific and technical information required by the Department in connection with agricultural and industrial research projects in hand in New Zealand. Much of this information, which was obtained at first hand, would not normally have been available through other channels. Assistance has also been given to New Zealand scientists visiting Australia.

SOIL BUREAU

Director: Mr N. H. Taylor

SOIL SURVEYS

Soil surveys have been continued in the Taupo, Gisborne, Foxton, and Central Otago areas. New surveys have been those of Kowai County (North Canterbury) and Wellington.

This year 20,000 acres of Manawatu sand country have been mapped, completing the field work for this part of the survey. Ten main soil units were recognized; chemical analyses show that most of the soils are high in plant nutrients, and soil moisture is the most important factor in soil productivity. In these soils the margin between too little water and too much is small, and interference with the water regime may cause pasture deterioration and erosion hazards. A very careful plan for drainage is necessary. There is an excellent correlation between soil type and grass-grub infestation.

Field work was completed on the 45,000 acres of Gisborne Flats with the addition of another 5,500 acres. The legend and 20 chain/inch map have been prepared and a detailed report is being written for publication. The work emphasizes that although the Gisborne Flats are high in plant nutrients they are highly productive only when the moisture content is not excessive. There is need for a close examination of drainage.

A further 65,000 acres of the Kaingaroa Forest have been mapped, completing the field work. The first part of the Taupo Survey has been completed with the mapping of a further 36,000 acres. Near Wellington a detailed survey of 35,500 acres of the Hutt and Paekakariki sheets has been completed.

A detailed survey has been made of the Horotane Valley, near Christchurch, for the North Canterbury Catchment Board. On one series of soils derived from loess, serious sheet and tunnel gully erosion is occurring. Remedial measures should include elimination of cultivation on slopes greater than 14° and better grassing of the catchment above the cultivation line.

In Kowai County, North Canterbury, 100,000 acres have been mapped on a scale of 2 mile/inch. There is a wide range in soil fertility; considerable erosion has occurred owing to the prevalence of silts and gravels and the breakdown of soil structure under cultivation.

A plan for boring has been prepared for the Maniototo Basin to locate accurately the depth, permeability, and salt content of the underlying clays. By this means the irrigation difficulties should be clearly seen.

Field work in the Manuherikia Basin has been finished with the addition of 1,200 acres in the Cromwell gorge. One of the purposes for this survey was to find if there was a correlation between tree diseases and soil type. There seems little correlation between "stone-fruit-blast" and soil properties.

With the completion of an introduction to the bulletin on the reconnaissance survey of the North Island, this project, which began in the war years, is now in final report form and is with the printer. A disastrous fire destroyed many of the soil map sheets that were being stored, so that only seventy-five complete sets remained. It has been necessary to get some of the maps reprinted.

At the request of the Fiji Government, a reconnaissance survey has been commenced. The soils on the western side of Viti Levu have been mapped. This constitutes about half the accessible farming land on the island, and lies between Tavua and Sigatoka. The soils are formed mainly from andesite or andesite alluvium. Erosion, both geological and accelerated, has been fairly rapid, and the topsoils are generally shallow.

Short-term investigations for other organizations have included soil maps for special areas for: Lands and Survey Department (Te Anau Basin and Lochar Settlement), Department of Agriculture (Waihemo County and soil typing of plots in Canterbury), Catchment Boards (Waimate Creek, Eyre River, Selwyn River, Heathcote, Upper Shotover, and Crown Terrace surveys), and town planning authorities (Tauranga, Te Teko, and Christchurch).

SOIL CHEMISTRY

Soil Phosphates.—Work on radioactive phosphorus has been continued. It has been shown that there is no significant influence of radioactivity on plant development or on phosphorus uptake in pot experiments when a range of specific activities from 40–2,560 microcuries per gram of phosphorus is used. A method has been developed for the estimation of P_{32} and P_{31} in the same small plant sample.

In co-operation with the Dairy Board, a preliminary survey to relate the fate of added phosphates to the dairy production has been made on farms in Taranaki.

Further work on the effect of heat on the solubility of phosphates in certain soils suggests that in the soils most affected by heat the phosphate is held by amorphous hydrous oxides. As shown by X-ray analysis, the amorphous particles rapidly increase in size on heating, with consequent lowering of the surface area and release of phosphate, which then becomes available to extractants and plants.

Soil Potash.—Progress has been made in fractionating soil potash. In line with overseas experience, it has been found that exchangeable potash (a common measure of availability) is not adequate to characterize some soils. Successive extractions with nitric acid indicate whether a soil is likely to have a reserve of potash or whether cropping will quickly reduce what appears to be an adequate amount of exchangeable potash. The Taupo pumice is a soil with a low reserve of potash, in contrast to one from Gisborne Flats with ample reserves for many years.

Analytical Methods.—A manual has been prepared of methods commonly used in soil survey chemical analysis.

Clay Minerals.—The importance of hydrous oxides of iron and aluminium in the behaviour of soils is emerging. For instance, yellow-grey earths contain the amorphous oxides, and the yellow-brown earths contain crystalline oxides. In the general survey on the relation of the different clay minerals to the genetic classification of soils, the usefulness of differential thermal-analysis curves is now showing up. The change of one mineral to a related one does not occur as a jump, but the endothermic peaks show a gradual transition, in line with the

field evidence. Similarly, once the genetic sequence is known, it is possible to recognize by electron micrographs the characteristic clay minerals on micro amounts of material. It thus provides convincing evidence of the presence of characteristic clay minerals in a minute amount of material, and holds out some hope of development in the forensic field. A method has been developed through differential thermal analysis of recognizing secondary quartz from primary quartz.

The effect of heat on the cation exchange capacity of clays is being investigated as a method of identifying components of complex mixtures of clays.

The surface properties of allophane, which causes abnormal physical behaviour in volcanic ash soils, has been further investigated. Its reactivity can be gauged by its surface area of not less than 200 square metres per gram.

Minor Elements.—A survey of the availability of elements for plant assimilation in various soil types is being carried out by means of spectrographic analyses on indicator plants. Such widely distributed plants as gorse, manuka, tussock (*Poa caespitosa*), paspalum, and sweet vernal have been tried. At present sweet vernal seems the most promising, for it is very responsive to its environment. The presence of varieties appears unimportant. The samples compared must be of the same physiological age. The elements estimated were Ca, Mg, K, P, Mn, Fe, and Cu.

SOIL PHYSICS

Soil Moisture.—Further studies on Taupo ash soils have shown that pasture has the most beneficial effect on water-storage capacity of these soils, bracken or scrub is next, and forest has the poorest effect.

Medium-textured soils have wilting points from 15–30 per cent and field capacities of 58–105 per cent moisture content. For the coarse-textured soils, wilting points ranged from 12 to 20 per cent and field capacities from 48–56 per cent.

Soil Mechanics.—Work has been continued on the physical properties of estuarine clays and silts, particularly at Gracefield Road (Wellington), Whangarei, and Lyttelton. Wide variations in salt content, shear strength, and consolidation characteristics, even within the same profile, emphasize the need for such investigations where the land is likely to be used for building purposes.

A number of smaller investigations have been made on sites for buildings, and these included railway workshops at Wanganui, Maunganui wharf reclamation, grandstand site at Nelson Park (Hastings), Government centre (Gisborne), Porirua housing scheme, Rongotai Airport extensions, Paritu loop subsidence, oil tank foundations for oil companies, and Paraparaumu Aerodrome extensions. A bigger investigation has been the Auckland–Frankton railway duplication at Mercer, where consolidation of clays within the swamps is necessary to enable a high-speed track to be constructed. An oil tank constructed on a site adjoining one previously condemned by the Soil Bureau failed during a test, with a 4 ft. settlement in the centre. The failure provides a useful correlation between the movement suggested by tests and the actual field settlement.

In addition to the service jobs listed above, the Soil Mechanics Laboratory has continued to act as a reference laboratory for the whole of New Zealand. Comparative tests have been made on the Tekapo compactor, liquid limit machines, vanes, and consolidation machines.

A beginning has been made in determining soils likely to show frost heave, a problem that has become intensified with the sealing of highways.

SOIL BIOLOGY

A study of the microbiology of shallow pumice soils has been commenced.

Earthworm Survey.—This survey is nearing completion, with field work done in Westland and at Waiouru. A good coverage of New Zealand has been obtained with the aid of other collectors.

SOIL CORROSION

Following the discovery that cement-asbestos pipes were corroded by groundwater containing CO_2, it was necessary to establish some standards of aggressiveness. Samples of cement asbestos were exposed to flowing water containing different amounts of CO_2. Corrosion was found to be independent of rate of flow of water once a critical velocity had been exceeded. Corrosion increases with increasing concentration of CO_2, but the rate of corrosion drops off after a time because the rate of diffusion to an uncorroded surface is slowed by the increasing thickness of non-corroding residues of the pipe.

Service jobs have included a strip survey of a proposed new pipe line for the Dargaville Borough Council and an examination of the soils round an earthing system of a radio station at Himitangi.

PUBLICATIONS

Some thirty scientific papers have been published or are in the press, in addition to notes or maps provided for articles in the *Journal of Agriculture* and similar journals.

TOBACCO RESEARCH

Station Director: Mr R. Thomson

Research during the past year, as in other years, has been carried out jointly by the Cawthron Institute and the Tobacco Research Station. Work conducted by the Institute has included chemical studies relating to the composition of the leaf from fertilizer, and curing experiments, disease surveys, and investigations concerning the control and spread of disease. Work at the Research Station has included seedling-bed investigations, fertilizer trials and cultural experiments, variety trials and seed production, curing experiments, and plant breeding to produce resistant varieties.

Weed Control.—Extensive trials on a commercial scale were carried out with methyl bromide for the control of weeds in seedling beds. Applied at the rate of 1 lb. per 100 square feet of bed surface, this material gave results equal to those of steam sterilizing. The seedbeds were covered with a plastic sheet or a cover made from laminated building paper. The plastic is the more durable and satisfactory, but the paper is considerably cheaper. The methyl bromide was obtained in 140 lb. cylinders, and the dosage measured by loss in weight. Chlorobromopropene applied as a drench gave promising control of weeds in the seedling beds.

Varieties.—Virginia Gold, a new variety introduced from the United States of America, has given excellent results under a wide range of conditions. On land infected with black root-rot it has proved highly resistant, and has produced a good yield of excellent quality leaf. Vamorr 50, and another imported variety, has proved resistant to mosaic and black root-rot and has also yielded well.

Plant Breeding.—Breeding for resistance to black root-rot was continued. Two lines were tested on heavily infected land, and proved to be highly resistant as well as producing an attractive type of plant. The tendency toward an inherited cigar aroma from the resistant parent appears to have been overcome. In the breeding for mosaic resistance it was necessary to discard all

the crosses of Ambalema origin on account of a factor causing wilting in hot weather. Good progress is being made in raising flue-cured types incorporating the resistance of *Nicotiana glutinosa.*

An intensive search is being made for material resistant to verticillium-wilt. Some lines have been discovered more resistant than the commercial varieties, and these have been used as parents in the meantime, but a much greater degree of resistance is required.

Kiln Design.—A commercial-size experimental kiln with fans to circulate the air and operating on the down-draught principle has been erected. Results have been encouraging. A much greater degree of uniformity of temperature and humidity was obtained than is usual in commercial kilns, the time required for curing was appreciably reduced, and a considerable saving in fuel was effected. Some modifications are still necessary in the design of the furnace.

DISEASE INVESTIGATIONS

These have included surveys of tobacco diseases in the seedling beds and gardens of growers; the control of black root-rot, verticillium-wilt and *Phytophthora disease;* and tests of susceptibility of different varieties of tobacco to *Phytophthora.*

Disease Surveys.—In January a survey was made of the tobacco gardens of twenty-two growers in the Motueka, Riwaka, and Dovedale districts. The amount of mosaic was low in the majority of gardens, the average percentage of infection being only 4·8. There were six gardens with more than 5 per cent infection, and in these gardens pricked-out seedlings had been used for planting.

Bad patches of black root-rot infection were seen in three gardens in the Motueka area and in four gardens at Dovedale. Angular leaf-spot was observed in six gardens and isolated instances of " streak " and ring-spot were recorded.

A careful survey was made of tobacco gardens in the locality where " canker " (*Phytophthora* sp.) occurred in the previous season. This disease was found in five gardens, two of which had badly infected areas. Three gardens affected last year were not used for tobacco during the past season.

Black Root-rot.—In the seedling-bed experiments for the chemical control of this disease, chloropicrin and D-D applied in the autumn gave excellent results. Clean roots were likewise found on plots treated with either micronized or flowers of sulphur at the rate of 2¼ oz. per square yard.

The value of sulphur for the treatment of tobacco land infected with black root-rot was again demonstrated in field experiments conducted on three properties. In two cases the use of 10 cwt. sulphur per acre broadcast, or 2 cwt. sulphur per acre sown up the rows before planting, had a favourable effect on the growth of the tobacco plants. Tobacco on plots receiving 4 cwt. sulphur per acre sown up the rows before planting showed some retardation of growth from over-concentration of the sulphur.

Tobacco-canker.—The susceptibility of twenty-two varieties of tobacco to cultures of *Phytophthora* sp. was tested in a series of pots. Typical stem canker was not obtained, but a dark-brown colour of the roots and the development of sporangia in soil leachates indicated infection in a large number of cases. Varieties showing considerable resistance to the disease were Oxford 1 and 3, Kentucky 34, Dixie Bright 101 and 102, Florida 301, and R.G. Varieties showing rather marked susceptibility to the disease were Vamorr 48, Amarello, Virginia Gold, Vamorr 50, and Harrison's Special. In a test of several strains of *Phytophthora* no difference in effect was found.

Verticillium-wilt.—In seedling-bed experiments, good results were again obtained by the use of chlorobromopropene at the rate of 4 ml. per square foot for the control of this disease.

CHEMICAL INVESTIGATIONS

The principal work has been connected with the chemical examination of tobacco-leaf samples collected from fertilizer, spacing, and curing trials at the Tobacco Research Station and experimental plots at Marahau.

Effect of Fertilizers on Tobacco Leaf.—With a constant nitrogen content of 3 per cent in the fertilizer and an application of magnesite, variation in the phosphoric acid and potash content of the fertilizer had little effect on the sugar content of the cured leaf, but the nitrogen content of the leaf tended to be lower with the higher rates (8 and 12 per cent) of potash in the fertilizer. In this, the first season after application of the magnesite, no definite effect on the magnesia content of the leaf was noticed. In the absence of magnesite, the highest sugars content of the tobacco leaf was associated with the 12 per cent rate of potash in the fertilizer. A reduction in nitrogen, lime, and magnesia contents of the leaf, and an increase in potash, occurred with increasing amounts of potash in the fertilizer. For a constant percentage of potash in the fertilizer, increases in the percentage of phosphoric acid in the fertilizers tended to increase the potash content of the cured leaf.

Field Experiments at Marahau.—In co-operation with the Tobacco Research Station, experiments have been continued to ascertain the cause of poor-quality tobacco leaf grown on certain sandy soils at Marahau.

In the 1950–51 season copper sulphate was applied to certain plots both as the dry salt and in solution. Copper salts reduced the nitrogen and increased the sugar content of the tobacco leaf; manganese and zinc contents of the leaf were reduced by the use of copper sulphate, but there was no effect on the molybdenum content.

In the spring of 1952, applications of zinc, copper, manganese, boron, and molybdenum were tried, but of these only copper gave a definite beneficial effect. The beneficial effect of copper was associated with a reduction in the nitrogen and an increase in the sugar content of the cured leaf. Data on the minor element content of the leaf, obtained over three seasons, show that when blotching of the leaf occurs the copper content of the leaf is low and manganese content is high. Boron, zinc, and molybdenum contents do not vary greatly from the apparently normal figures of 15, 50, and 1 p.p.m. respectively.

Leaf affected with blotching has been obtained in other parts of the Nelson district, and has likewise been found to be low in copper content, in some instances containing only 2 p.p.m.

Curing Experiments.—Samples of tobacco leaf used in the curing experiments at the Tobacco Research Station have been analysed for sugars and nitrogen contents. The analytical data show that, within a given lot of leaf, variation in temperature of colouring from 85° to 95° F. at constant relative humidity produced no significant effect on the sugar content of the cured leaf. Colouring carried out at 95 per cent relative humidity gave lower sugar contents in the cured leaf than with 75 per cent and 85 per cent relative humidities.

SOILS AND FERTILIZERS

A number of soil samples from different parts of the Nelson district have been examined for lime and plant food content and reports furnished to the Tobacco Research Station.

WHEAT RESEARCH INSTITUTE

Director: Mr E. W. Hullett

Wheatgrowers, flourmillers, and bakers have agreed to support the Institute for a further period of five years. They have also agreed to an increase of ½d. in

the levies. This will mean 3d. per ton of flour from millers and bakers, and 3d. per 50 bushels of wheat from wheatgrowers. The levies from flourmillers and bakers provide about half the cost of the Wheat Research Institute, and the wheatgrowers' levies go towards the cost of wheat breeding at the Crop Research Division.

WHEAT

Improvement of Quality.—Associated with the yearly task of testing the baking quality of many new wheats bred by the Crop Research Division, there was this year a thorough review of the policy that should be followed to bring about an improvement in the breadmaking quality of New Zealand wheat. This policy must take account of both technical and economic limitations. In the new wheat, Hilgendorf, the major technical limitation has largely been overcome in that Hilgendorf has a very high baking quality and a yield only slightly below that of the standard variety Cross 7. There remains the economic problem of finding a procedure whereby the small extra cost of Hilgendorf due to its slightly lower yield can be recovered directly or indirectly from the bread consumer. If this problem can be overcome, the prospects of a marked improvement in bread, especially in its keeping quality, will be good.

Handling.—Interest of farmers in bulk handling of wheat was less than in the previous year, but there were still many inquiries about this and the related question of wheat drying. A survey in Southland showed that harvest problems are not severe enough to cause farmers to think that any considerable expenditure on wheat-drying equipment is warranted. The Institute will, however, continue to watch progress in wheat drying and storage methods.

Harvest of 1953.—The Institute was able to show that the shrivelled wheat of this harvest had very good baking quality in spite of its low bushel weight and low flour yield. This led mills to accept it more readily than they otherwise would have done.

MILLING

Flour Extraction.—At the request of the Wheat Committee, the Institute made laboratory and full-scale trials to show whether a reduction in the rate of flour extraction from 78 per cent to 75 per cent would give an appreciable improvement in bread quality. As was expected, the trials did show an improvement in flour quality, but not one sufficient to justify the annual cost. The saving made by the relatively high extraction rate would be better spent in encouraging the growing of high-quality wheat than in lowering the extraction rate.

BAKING

Bread Yield.—An extensive series of observations was made in bakeries to find how many loaves are produced from a ton of flour under various bakery conditions. The work was undertaken at the request of the Price Control Division, Department of Industries and Commerce, but the opportunity was taken to measure the yield losses from various causes, and to study the difficulties bakers have in achieving the loaf weights required by law. Average loaf weights must be high enough to prevent downward variations from resulting in underweight loaves. It was found that the extra weight needed to cover weight variations with an exceptionally good divider meant a loss of yield of 12 lb. and with a poor divider 74 lb. of bread from a ton of flour. Ovens that give uneven weights are responsible for similar losses in yield. Findings of this kind can be used to determine whether machinery should be overhauled or replaced. Baking and cooling losses varied by as much as 130 lb. of bread per ton of flour for one kind of bread. This means that some bakers have to use

about 1½ oz. more dough than others to reach a 2 lb. loaf weight. Because of this, an Australian system of regulating the sale of bread by dough weight instead of loaf weight is being examined from the technical standpoint.

GENERAL

Extension Work.—A procedure was instituted whereby information on the baking treatment suitable for each brand of flour is sent to bakers once a fortnight. This is helping bakers to make allowance for changes in flour characteristics.

Courses in baking were held for apprentices and for senior bakers.

Officers dealt with many problems both by letter and by direct visits to mills and bakeries.

Chemical Investigations.—The growth in advisory and service work curtailed attention to the long-term study of the dough ripening process, but nevertheless considerable progress was made. This work has gained in significance following discoveries made by the Research Association of British Flourmillers that were developed from previous work at the Institute.

Publications.—Nine technical articles for bakers were published.

OTHER REPORTS

CAWTHRON INSTITUTE

Director: Sir Theodore Rigg

Aided by grants from the Department of Scientific and Industrial Research, work has been carried out on a wide range of problems connected with the tobacco, hop, fruit, and tomato industries of the Nelson district. Other important work of more general application has included entomological, soil, and plant nutrition studies.

In tobacco, hop, and entomological investigations the Institute collaborates with officers of the Department of Scientific and Industrial Research, and the work of the Institute is reported conjointly with that of the Department under the heading of Tobacco Research, Hop Research, and Entomological Research Station in other sections of this annual report.

SOIL INVESTIGATIONS

Classification of South Island Soils.—In co-operation with the Soil Bureau, representative soil samples from the Takaka, Collingwood, and Buller Counties have been collected and analysed for base status and plant-food content to complete the classification of soils in the northern part of the South Island.

Detailed Surveys of Alluvial Soils in the Waimea County.—The alluvial soils of the Motupiko and Tadmor valleys, not included in the earlier surveys of tobacco soils, have been mapped, and samples taken for laboratory examination. Soil and land-use maps of the lower Motupiko valley and of the Tadmor valley have been completed as far south as Tui. In both valleys, raspberries, hops, or other intensive crops are grown, and pastures are capable of great improvement.

Survey of Marginal Hill Country, Waimea County.—In co-operation with the Nelson Catchment Board and interested Government Departments, the Institute has commenced vegetation, soil, and land-slope surveys of some 60,000 acres of foothill country bordering the Waimea Plains. Some of the land gives good results with sheep grazing, but there are considerable areas of deteriorated rather steep slopes that present difficulty in utilization for both agriculture and forestry.

PLANT NUTRITION INVESTIGATIONS

Studies of the role of trace elements and other mineral constituents in Nelson crops have been continued.

Minor Elements in Raspberry Leaves.—The use of manganese sulphate in sprays raised the level of this element in the leaves to an average figure of 170 p.p.m. Soil top-dressings with manganese sulphate resulted in a content of 500 p.p.m. in the leaves.

The use of copper spravs and top-dressings of copper salts did not increase the copper content of the leaves above the normal figure of 15 p.p.m.

Suspected Copper Deficiency of Tobacco.—An unsatisfactory condition of tobacco leaf grown at Marahau appears to be due to a deficiency of copper. Typical samples of leaf showing a characteristic brown blotching contained 3 to 6 p.p.m. of copper. Healthy leaf from the Tobacco Research Station contained 27 to 40 p.p.m.

Tobacco leaves from other parts of the Nelson district sometimes show symptoms of disorder similar to that found at Marahau and are equally low in copper—in one instance giving the very low figure of 2·1 p.p.m.

Intake of Plant Nutrients by Hops.—Complete hop plants have been separated into cones, leaves, and bines. These have been weighed and then examined for dry matter, nitrogen, and mineral contents, as a basis for calculating the total intake of plant nutrients in different parts of the plants. The results show that nitrogen and potassium are the two plant elements required in large amount. Calculations show that 1 acre of hops (1,200 plants) removes in a good crop of cones plant foods equivalent to 1 cwt. dolomite, 2 cwt. superphosphate, 2 cwt. sulphate of potash, and 4 cwt. sulphate of ammonia.

FRUIT RESEARCH

The more important investigations this year have included the effect of trace elements on raspberries at Motupiko and Rakau, the continuation of zinc and copper deficiency experiments on apple trees at Tasman, and the investigation of the effect of *Neofabraea malicorticis* in causing cankers on the trunks and limbs of pear and apple trees.

Boron Deficiency of Raspberries.—To obtain more accurate information on the effect of boron on the growth and foliage of raspberry bushes, a series of sand-culture tests has been established. The omission of boron from the culture solution has resulted in marked leaf distortion. Affected leaves contain only 4 p.p.m. boron, compared with 20 p.p.m. in healthy leaves.

Zinc and Copper Deficiencies.—Zinc sulphate sprays at 2½ per cent and 5 per cent strengths have been continued on a block of Gravenstein trees at Tasman, but leaf samples from the sprayed trees did not show any increase in zinc content.

A dilute solution of copper sulphate tested on apple trees in the spring gave no improvement in leaf condition.

At Motupiko, copper sprays on raspberries have greatly benefited the foliage, which remained healthy till late autumn. Unsprayed plots, or those receiving manganese sprays only, lost their leaves early in the summer. This result again raises the question as to whether the beneficial effect of copper sprays is exerted through its fungicidal action alone or through an additional nutritional effect.

Apple Stock Experiments at Annesbrook Orchard.—Tests of Double Vigour (French crab vegetatively propagated) and Northern Spy stocks for the Statesman variety continue to show the superiority of Double Vigour stock for this variety, both in tree growth and yield of fruit.

Tests with a vegetatively propagated stock from Epps' Seedling continue to give greater growth and higher yield of fruit with both Cox's Orange and Jonathan varieties than the Northern Spy stock. In the 1953 harvesting season the yields for Cox's Orange were 182 lb. on Epps' Seedling and 142 lb. per tree on Northern Spy stock. The yields from Jonathan variety were 227 lb. and 150 lb. per tree respectively for the two stocks.

Disease Investigations.—A detailed examination of cankered tissue obtained from dying Bon Chretien pears and from Sturmer trees in orchards located at Stoke and Hope has revealed the presence of *Neofabraea malicorticis,* which is considered to be the fungus causing the death of both pear and apple trees in the two orchards.

One form of the disease (ripe-spot) is common in many orchards of the Nelson district, and special sprays are used for its control on Sturmer and other late varieties of apples. The identification of the disease in cankers on the trunks and limbs of fruit trees suggests the desirability of applying a strong Bordeaux spray in the late autumn to prevent canker formation which not only affects the health of the trees but results in spore formation infecting thereby the fruit in the summer.

TOMATO INVESTIGATIONS

Work on tomato problems has been continued along similar lines to that of previous years.

Tests With Steam and Soil Disinfectants.—Steam, chloropicrin, D-D, and a mixture of chloropicrin and D-D were tested under glasshouse conditions with a standard fertilizer mixture at the same rate for each plot. Chloropicrin and the mixture of chloropicrin with D-D were again comparable with steam treatment in total yield and quality of fruit. The percentage of first-grade fruit showed only a small variation with the different treatments.

Value of Compost for Glasshouse Soil.—Compost (rotted clover straw) used at the rate of 15 tons per acre for the seventh successive season, in conjunction with steaming and a standard fertilizer programme, again gave the highest yield and slightly better quality.

Effect of Additional Potash and Nitrogen Applications on Quality of Tomatoes.—In every case, additional applications of nitrogen or potash, or nitrogen plus potash, resulted in a great improvement in quality of fruit. In every case there was a reduction in the amount of "cloud" in the tomatoes as a result of the above fertilizer supplements. In the nitrogen plus potash supplements, cloud was reduced to a negligible amount.

"Cloud" Investigations.—Further observations have been made on the effect of different factors in inducing or controlling cloud in glasshouse tomatoes.

Pot experiments supplemented by determinations of dry matter and carbohydrates in the fruit have shown a marked association of cloud with low dry-matter and low carbohydrate content of both fruits and leaves.

Intake of Plant Nutrients by Glasshouse Tomatoes.—Complete records have been obtained concerning production of dry matter and intake of plant nutrients at different periods of the growing season. The results confirm those obtained in a previous year, and show clearly the extraordinary demands made by developing fruits on plant nutrients during the latter part of November and throughout December and January.

"Hard Core" Investigations.—The susceptibility of five varieties of tomatoes to hard core has been determined. The results show that Kondine and Exhibition varieties are particularly prone to this disorder and that the Invincible variety is very resistant.

COMMONWEALTH AGRICULTURAL BUREAUX

Collaboration on a Commonwealth-wide basis, in the field of scientific information, was established some twenty-five years ago by the Commonwealth Agricultural Bureaux (C.A.B.). The organization consists of ten Bureaux, three Institutes, and a Headquarters, all but one of which are located in the United Kingdom, but serve, in particular, all parts of the British Commonwealth.

The main functions of the C.A.B. are the preparation and publishing of journals containing abstracts of the world's scientific literature relating to agriculture and forestry, and the publishing of monographs on particular subjects in these fields. This and the other services of the C.A.B. enable research workers to keep in touch with the very extensive literature on these subjects with the minimum of time and expense.

The Governments of the Commonwealth contribute financially to the support of the Bureaux, and the funds are augmented by the world-wide sale of their publications. The C.A.B. is represented in New Zealand by a Liaison Officer, who is a member of the Department, and by thirteen specialist Official Correspondents, in this and other Departments, each representing a Bureau or Institute.

The Department's Scientific Adviser in London, Dr E. Marsden, is Chairman of the Executive Council.

INCORPORATED RESEARCH ASSOCIATIONS

THE DAIRY RESEARCH INSTITUTE (N.Z.)

Director: Professor W. Riddet

The financial year of the Institute ends on 31 July next, when a separate report will be issued by the Institute. The following summary, not included in the Department's 1952 annual report, covers investigations for the year ended 31 July 1952.

Butter.—The work on the steam distillation of tainting substances from cream has been continued. Progress has been made in the study of the deodorizing machines in commercial operation by use of suitable reference substances added to the cream before treatment.

The investigations, extending over several years, of the effect of the omission of the washing stage in the manufacture of butter have now been completed, and a report is to be published. The non-washed butter prepared under both experimental and commercial factory conditions was of equivalent quality to washed butter from similar cream, even when the cream was of poor quality, and there was no appreciable difference in the keeping qualities.

The treatment applied to cream prior to churning usually induces some changes in the state of dispersion of the butterfat, and these affect the fat losses in churning and the character of the butter. It has been shown that vacreator treatment of cream causes a considerable increase in the proportion of fat present as small globules and a smaller increase in the proportion present as large globules; and that flash pasteurization causes a slight decrease in the proportion of small globules but a considerable increase in the number of large globules. These results explain the larger fat losses from the churning of vacreator-treated cream, and may explain the superior texture of the butter from such cream.

The storage flavour of butter has been further investigated. The results indicate that the defect is in the butterfat and not in the serum.

Investigations on the seasonal changes in the properties of New Zealand butterfat are being continued.

The normal grease-penetration tests for investigation of the quality of parchment were found to be inadequate as a basis of judgment of the grease-resistance of some types of commercial parchment. An oil-absorption test has been developed to supplement the information provided by these tests.

An investigation has been made, on a semi-commercial scale, of the separation of fat from buttermilk.

Cheese.—The search for fresh strains of streptococci suitable for use as cheese starters has continued. Of three strains received from England, only one proved suitable. The Institute has now ten unrelated stock strains of *Str. Cremoris.*

A slight decline in the quality of New Zealand cheese in 1950–51 raised the question as to whether the widespread use of penicillin by farmers could be a causative factor. Experiments were conducted throughout the past season, but—in view of the purely non-specific effect of penicillin, which results in merely a delayed growth of the starter organisms and a consequent delay in acid production—they did not give a clear-cut answer. There are many factors besides presence of penicillin in the milk that could, in a given dairying season,

cause a decline in quality, and the whole situation needs to be kept under review for some years until the usage of this antibiotic by farmers becomes stabilized.

The Institute in previous years has made several tentative approaches to the problem of controlling the flavour of cheddar cheese. The essential constituent of cheddar cheese flavour has not yet been identified. Recently a suggestion has been put forward by overseas investigators that tyramine has some connection with cheese flavour, but this suggestion is not confirmed by the work at the Institute. An attempt is being made to isolate and identify the flavouring substances in a good cheddar cheese.

An attempt, made in a commercial factory in collaboration with the Department of Agriculture, to improve the accuracy of standardization of the fat content of cheese was not successful. The results indicated that the standard of accuracy is limited by inherent sampling, and analysis errors in the examination of the final cheese.

The Institute continued to manufacture blue-veined cheese on a pilot-plant scale, with an annual output of 10 tons per annum. Using the experience gained at the Institute in this pilot plant, a commercial firm has now established a plant that has an annual capacity of 150 tons.

Fundamental information on the effects of humidity on the shrinkage of 80 lb. export cheeses has been obtained, and recommendations have been made to the designers of air-conditioning equipment and to factory operators.

Commercial Casein Manufacture.—Technical assistance on methods of manufacture has been given; an endeavour has been made to relate tests and methods of analysis used by overseas buyers to those adopted in New Zealand; and the cause of occasional non-clotting of the milk in the manufacture of lactic casein has been determined.

Market Milk and Cream Studies.—An investigation of the reconstitution of liquid milk from dried skim-milk and cream provided a basis for the trial of reconstituted milk as a part source of milk for the milk-in-schools scheme during the winter. Studies have been made, too, on the relation between pasteurization and storage temperatures and keeping quality of frozen cream.

Dried Milks.—An improved multiwall paper bag for the packaging of buttermilk powder was tested, but it was found to be more susceptible to puncture than the alkathene-lined fibreboard carton now in use.

Engineering Studies.—Investigations have shown that there is a wide variation from factory to factory in the quantity of coal used per ton of butter manufactured, and the cause of these variations is being sought. Advice has been given to commercial factories on the selection and operation of factory equipment and on the relation of boiler capacity to steam requirements in the factory. The work has stimulated factory mangers and directors to take a greater interest in the possibilities of prevention of the fuel wastage that can occur as a result of inefficient steam-raising equipment, of inefficient steam utilization, and of unnecessary loss of heat from various causes.

The work on farm milk coolers has been continued. The results of the work have wide application in many heating and cooling operations in dairy factory practice.

Milk Production Investigations.—These projects include a study of the relation of milking-cow nutrition to properties of butterfat, the repeatability of successive records of production of cows, the relation of lactational average fat to S.N.F. content of milk, the loss of weight by dairy cattle in the early stages of lactation, the influence of weather on dairy stock, and a calf-feeding experiment.

NEW ZEALAND FERTILISER MANUFACTURERS' RESEARCH ASSOCIATION (INC.)

Director: Dr B. W. Doak

In the past year the Association's work was hampered by its being without a Director for a period of six months.

Rock Phosphates.—The fertilizing efficiency of ground rock phosphates was studied on a range of soils in which both radishes and subterranean clover were used as the test crops. The North African rock phosphates gave much greater responses than Christmas and Nauru Island phosphates. In general, the rock phosphates gave the best responses when ground sufficiently fine to pass a one hundred mesh to the inch sieve. Grinding finer than this did not consistently improve the fertilizing efficiency.

Types of Fertilizers.—The most promising fertilizers from previous experiments were more closely investigated, subterranean clover being used as a test crop. Generally there was little to choose among the standard fertilizers such as superphosphate, basic slag, and superphosphate, basic slag, and superphosphate reverted with either lime or serpentine. A fused calcium magnesium phosphate from the United States of America gave good results when finely ground. Samples of fused calcium magnesium phosphate made at the Dominion Laboratory from New Zealand materials are now being tested.

Grass-grub Investigations.—In co-operation with the Department of Agriculture, trials to measure the degree of control of grass-grubs given by applications to the pastures of mixtures of DDT and fertilizers have been conducted on local farms. The applications were made at different seasons and rates per acre, and for some reason results on local pastures have not been consistent.

Radioactive Phosphorus Studies.—Radioactive phosphorus has been used in the laboratory to measure the exchange between the phosphorus in rock phosphates and the solutions with which they are shaken. The exchange was greatest with those rock phosphates that when applied to soils are the more effective fertilizers. Laboratory and greenhouse work with radioactive phosphorus is proceeding to test methods of measuring in soils the phosphorus available to plants.

Chemical Measurements.—In the laboratories of the various fertilizer works much time is spent in the determination of the amount of phosphorus in rock phosphates and fertilizers. Accordingly, a thorough survey of the standard method and a new chemical method of determining phosphorus has been made so that the best method can be selected.

A check is being made to test the suggestion of Hendricks of the United States Department of Agriculture that there might be a correlation between the carbon dioxide evolved from a rock phosphate treated with dilute acid and the phosphate that goes into solution. Both products are presumed to be derived from the readily decomposable carbonate-apatite (collophane) mineral fraction of the rock phosphate.

General.—During the year four general reports and two research reports were circulated to interested groups throughout the country. The circulation of technical journals and papers to members was continued.

THE NEW ZEALAND LEATHER AND SHOE RESEARCH ASSOCIATION (INC.)

Director: Mr F. W. Woodroffe

Leather Manufacture.—The corrected grain-finish has been further developed and has been very well received by the shoe manufacturers. Problems

relating to the feel and handle have been solved, and this type of production has now been firmly established.

Work on masked chrome liquors has had two useful applications. Firstly, the requirement was for a woolled sheepskin with good strength and a minimum substance because it must be used as the lining of bootees. Work on the acetates indicated that by the application of such salts at the end of the tannage large chrome complexes are broken down, and the resulting leather was of light substance. The second application was to New Zealand sheep pelts that were particularly coarse and wrinkled in the necks. After the usual chrome tannage a very large proportion of such skins break in the setting-out machine. It appeared that an even tannage throughout the structure was of importance and any tendency to overtan the grain and so set up strains in the structure was to be avoided. Studies showed that the use of formates along with the tanning salt enabled the production of level chroming throughout the structure, and there was no evidence of the coarse neck being fixed. In the striking-out machine the necks did not break and the coarse structure was levelled down, giving an improved product.

During the year considerable work has been done with a view to stabilizing production in the various tanneries. By means of layer analyses of the leathers the tannage and fat deposition has been checked and suitable modifications have contributed to the production of a more uniform leather.

Hides and Skins.—Freezing works' activities have been based on three lines of approach: Firstly, the use of sodium hydrosulphide was studied in large-scale trials at three North Island freezing works. There are certain advantages in the improved wool and smoother pelt, but against these there is a slightly slower pull. One firm has used sodium hydrosulphide for the whole season and is very satisfied with the results. In order to establish the expected improvement in the leather, 600 skins have been despatched to England for tanning, and a full report on these will be received. One criticism is that the skins lack substance, but this is largely an illusion as all the skins tanned at the laboratory have come out as particularly full strong leather.

Secondly, the work on heat deterioration of pickled pelts has been pressed forward. After establishing the effect of heat in storage and during transportation, the use of various strengths of acid in the pickle dolly was investigated. An important result was that the heat deterioration at any given temperature was directly proportional to the acid remaining in the used pickle liquor. The present concentration of 0·8 to 1·0 per cent sulphuric acid is based on the findings of the British Leather Manufacturers' Research Association and is laid down as necessary to prevent mould growth. Actually acid is not an ideal medium for the control of mould—last year considerable trouble was experienced with the mould *Alternaria tenuis,* which grows on correctly pickled skins. Trials varying the salt content proved that this was not a significant factor in the deterioration. The next step was to devise a pickling process with less acid and use it in conjunction with a fungicide to control mould growth. A range of fungicides was selected from those available that would not modify the colour of the pelts. This is an important matter, as large numbers of New Zealand pelts are used as white, washable glove leather. Accordingly, certain very powerful fungicides, such as para nitro phenol, that give an intense yellow colour when alkaline were ruled out. *B. naphthol* was found to be satisfactory in the trials and has now been recommended to the industry. Meanwhile trial shipments in which a low acid concentration and *B. naphthol* were used have been sent to England for examination and report by the tanners.

Thirdly, research has been carried out on bobby calf skins, which are an important export from New Zealand. There have been complaints of a serious loss due to a deposit on the grain and flesh, which reduced the value of these

skins. Investigations showed that this spot contained calcium, sulphates, phosphates, and sometimes carbonates. Trials led to the assumption that the inorganic phosphates arose from post-mortem changes brought about by enzymes in the tissue, and that where there was calcium sulphate present in the salt, reaction took place, resulting in these deposits. With the co-operation of one of the Association's members, a series of trials was held to test this hypothesis. Bacterial growth on calf skins is objectionable, so certain germicides were included; salts of varying calcium content were used and regard paid to the pH of the salt on the supposition that enzymes were usually sensitive to the pH of the media. Twelve experimental lots were prepared, and eleven of these were despatched to England and returned before opening. Two of the different treatments showed complete absence of spot. The skins are now being tanned and finished as shoe leather so that the influence of the various treatments can be assessed on the finished production.

In addition to these investigations, extensive service to the industry by analyses and microscope assessment of their productions has been given.

Footwear Manufacture.—Over one hundred complaints relating to footwear have been investigated, and recommendations for improvement have been made. Most of the cases were due to customer abuse, and many complaints against manufacturers were not justified.

A new detergent for use in the final cleaning and finishing of shoes has been developed. Its great advantage is that it will remove dirt and grease without disturbing the finish on the leather, and so avoids the retouching of the shoes to restore the colour.

Conferences.—During the year four very successful conferences were held of technicians and chemists in the three groups of trades. These are being greatly appreciated by members. In 1950, 23 attended the Freezing-works' Conference, 33 in 1951, and 40 in 1952. At the last Footwear Conference, 56 were present.

THE NEW ZEALAND POTTERY AND CERAMICS RESEARCH ASSOCIATION (INC.)

Director: Mr W. Vose

Since the Association two years ago extended its operations into the fields of heavy-clay products, viz., bricks, roofing tiles, drain pipes, etc., many new activities have been introduced. The full development of these activities has been hindered to some extent by the lack of suitable premises, occasioned through delays in establishing the new laboratories.

Finer Wares (Whitewares)

Raw Materials.—It has been shown that the particle shape of china clays is an extremely important factor in their suitability for pottery: the disappointing results from certain New Zealand deposits is thus explained. Precise selection can now be made, and many potential china clay deposits have been tested. Further examination of the Mount Somers decomposed rhyolite, an extensive china-clay deposit, shows that the quartz diluent varies with depth, and mining is now concentrated in the high clay areas.

Potential ball-clay deposits have been examined, but no new sources of whiter firing plastic clays have been revealed.

The lower firing temperature of some clays has been elucidated. Alkali containing fine clay minerals such as illite are the cause.

Extensive investigations into the benification of material from three local sources of felspar are almost complete. The highest grades of felspar can be produced, and the economics of the various processes are now under examination.

More precise and more rapid test methods of various kinds have been developed, and are in use in the laboratories of the association and at member firms.

Processed Materials and Processes.—Fundamental investigations into the role of the various constituents of porcelain and earthenware have been extended.

The causes of "dunting", a characteristic cracking of ware in the kiln, were traced to variations in the quartz content of the china clay. The manufacturing losses from this cause were thereby removed.

Further investigation into the weaknesses of vitrified hollow-ware showed that other causes existed than those determined earlier. A persistent cracking of major consequence in sanitary ware production necessitated a change in composition to increase the unfired strength and remove the trouble.

Heavy Clay Products

Raw Materials.—The materials in use and of possible value to the industry have been the subject of a survey from the inception of the heavy clay work. The list of clays examined is quite lengthy.

From this work a clear picture of the characteristics of available materials is emerging, and the steps necessary to remove manufacturing difficulties due to raw materials can be more precisely determined.

An outbreak of yellow and green staining of brickwork caused by traces of vanadium compounds in the clay was investigated. Although the trouble can be controlled, the phenomenon is not clearly understood.

Production Equipment.—The results of experimental and pilot scale experiments upon the use of pulverization of clays to improve the manufacturing processes have been extended very successfully into the production field. A new type of unit to pulverize and mix wet clays shows great promise. Design has been commenced for the introduction into New Zealand works of electrically heated screens for sieving wetter materials than is possible at present.

Firing and Drying.—With the appointment of a heat and production engineer, a survey was made of the kilns in the industry. Subsequently, investigations into the operation of Hoffman kilns led to design modifications, resulting in better products and savings in fuel.

Preliminary design work for improved down-draught kilns has commenced.

General

A large and miscellaneous assortment of lesser problems have been dealt with during the year.

There has been a wide range of consultations with members concerning their plants and processes, both at their establishments and at regular meetings of the Association. These activities have played an important part in the life of the industry, and have resulted in beneficial changes in the plants and products.

Publications

Sixteen interim reports and three information leaflets have been issued in addition to individual confidential reports to members. Four research papers by members of the staff were published in overseas technical journals, including two contributions to *Nature*.

NEW ZEALAND WOOLLEN MILLS' RESEARCH ASSOCIATION (INC.)

Director: Dr L. F. Story

The staff was much depleted in the early part of the year, but this has now been remedied by several changes and additions, the chief being the arrival of a Research Officer from England and at the end of the year the appointment of a Massey College diploma holder.

Early-shorn Wool.—Wool shorn before lambing has a poor reputation with wool buyers, who claim that it is short and shows a high loss as noil and waste in worsted processing. Three kinds of early-shorn wool should be distinguished: (*a*) early-shorn hogget wool which is short and like lambs' wool in some respects, (*b*) "nine-months'" wool from sheep shorn at the usual time the previous season, and (*c*) "twelve months'" wool from sheep shorn early the previous season. It is agreed that the first kind is short and quite likely to be unruly in processing, and also that the second kind (which should eventually be a minor proportion of the clip) is short, but it is difficult to see why twelve months' early-shorn wool should be appreciably different in length and behaviour from twelve-months' late-shorn wool. It is thought that perhaps all early-shorn wool is being condemned because some kinds are dissimilar to late-shorn wool.

In order to see if there is any foundation for the wool buyers' claims as applied to twelve months' wool, comparative manufacturing trials are being run. One trial of 58's Corriedale wool has been completed, and a second of 48's quality crossbred wool is in progress. In these trials two lots of wool, one shorn before lambing and the other after, are being processed in succession on the same machinery, and in neither case has any appreciable difference between the two lots been found apart from the longer time taken to sort the early-shorn wool owing to its more open nature. In particular the percentages of noil were as follows (batches of 400–600 lb.):

	58's Per Cent	48's Per Cent
Early-shorn	8·4	2·9
Late-shorn	9·2	2·7

The conclusion drawn from the results obtained so far is that after the wools have been scoured there is no appreciable difference in behaviour between early-shorn and late-shorn when both have had approximately twelve months' growth.

The wools so far used have been derived from different clips. This year the Association is collaborating with the Department of Agriculture's research station at Invermay, which has a flock half of which is shorn before lambing and the rest after. Detailed data on fleece weights, staple lengths, yield, and yolk contents will be obtained, together with data from the nearby Taieri meteorological station on the weather, and it is hoped to obtain sufficient early and late-shorn wool for a manufacturing trial.

Effect of Copper on Wool Dyeing.—A striking full-scale demonstration of the effect of copper was unintentionally obtained in one of the early-shorn wool trials as one of the lots contained 52 p.p.m. copper derived from too generous use of a gammexane-copper sulphate dip. It dyed to a shade quite different from its companion lot which contained only 11 p.p.m. copper. Papers and a letter on this work have now been published in one overseas and two New Zealand journals.

Use of Nylon in Socks.—Last year it was reported that nylon splicing gave improved resistance to abrasion (at the heel and toe), and tests have now shown that staple nylon blended with the wool gives a still greater resistance to abrasion over the whole of the sock.

Drawing.—The worsted-drawing machinery at a mill has been examined in detail, and a number of alterations made to correct differences between machines,

to even out the drafts on successive machines, to simplify working by reducing doublings to some extent, and to increase production by making a greater range of roving weights, by increasing the weight of the tops, and by speeding up some of the machines. Evenness tests on material processed have shown that it was at least equally as even as before any alterations were made.

Stump Socks.—Samples of English and New Zealand made stump socks have been examined for the Social Security Department and for the Civilian Amputees' Association, and recommendations made.

RESEARCH INSTITUTE OF LAUNDERERS, DRYCLEANERS, AND DYERS OF NEW ZEALAND (INC.)

Research Officer: Mr P. Carlyon Coates

Despite lack of staff and the severe limitations of space in the present temporary laboratory, there has been an increase in volume of work handled. The Institute is shortly moving to larger laboratories.

General Investigations.—Problems on fabric damage and stain removal have approximately doubled during the past year, and have shown a fivefold increase over the past two years.

There has been an increasing number of textile materials submitted for test on their serviceability to laundering and drycleaning. It is hoped that in time the information provided will materially decrease the number of unserviceable garments on the market. Serviceability testing has also included work for Government Departments, e.g., shrinkage tests on Army socks.

Protective Gloves.—Further work has been carried out upon protective gloves for use in drycleaning plants. These gloves help to guard employees against dermatitis caused by contact with the solvent. So far, only neoprene gloves of American origin appear suitable, but work is continuing in an effort to find a satisfactory article from sterling areas.

Filter Powders.—Examinations have been made of diatomaceous earths of German origin to determine whether they would provide a satisfactory substitute for the American filter powders at present used in drycleaning. So far a satisfactory product has not been found outside dollar sources.

Laundry Alkalis.—Tests were carried out in two groups of laundries—one using sodium carbonate and the other using sodium metasilicate as a laundry alkali. Results showed that the laundries using sodium metasilicate produced significantly whiter work than those using sodium carbonate (which has been widely used in the past). There was no significant difference in the loss of tensile strength of the fabric between the two processes. In both cases the loss of fabric strength was slight. Figures showed that the processes using sodium metasilicate gave higher-quality work at lower cost. These results have been of particular interest to Hospital Boards as pointing the way to greater efficiency at lower cost.

Bleaching Efficiency.—A project to solve the problem of efficient bleaching with minimum damage to the textiles has been commenced, and this should have value in both laundering and drycleaning. A standard browned fabric is being developed to provide a measure of the efficiency of the bleaching process.

Raw Materials.—Analyses have been made of a number of samples of raw materials used in the laundry and drycleaning industries, e.g., soaps, solvents, water, etc. Many of these have been connected with advice upon processes, and in some cases have shown how members could effect substantial savings in costs.

Visits.—Visits have been made to members' plants, and advice provided on processes, layout of plant, and other problems. Shortage of staff has necessitated some curtailment of this service over the past year.

Annual Convention.—The fifth annual convention of the industry was held at Auckland, in conjunction with an exhibition of up-to-date machinery and equipment arranged by allied traders. These events, which are conducted and financed independently of the Institute's research activities, were attended by delegates from areas throughout the country. They proved an excellent opportunity for lectures and demonstrations on technical subjects. The lectures were later issued to members in book form.

Information.—There has been a definite change in emphasis in the bulletins regularly issued to members. In the past these have been largely a means of distributing to members technical information from overseas. Over the past year, bulletins have been written to deal with the particular needs of the industry in New Zealand.

MANUFACTURERS' RESEARCH COMMITTEE

Secretary-Executive Officer: Mr C. P. McEvedy

The Committee is responsible for promoting research in the manufacturing industries. Manufacturers are encouraged and assisted to participate in research activites and to utilize scientific facilities available through the Department. Through these measures there is a wider appreciation by industrialists of the importance of science in raising efficiency, quality, and output.

Close relationship has been maintained with the New Zealand Manufacturers' Federation, and arrangements were made for articles dealing with industrial research to be published in the Federation's monthly journal.

Co-operative Research.—The activities of the incorporated research associations, which are financed by equal contributions from industry and Government, are reviewed regularly. These organizations now form an integral part of their respective industries, for which they successfully carry out research and other scientific work that is of immediate practical benefit. The success of the associations is due largely to the co-operation of member firms in arranging research programmes and to their enthusiasm in promptly applying the results to factory operations. The progress made by the Associations has made the need for adequate laboratory space urgent in three cases: during the year one transferred to new accommodation, and arrangements for better accommodation for the other two are well advanced. In order to provide facilities for co-operative research in industries that are too small to support incorporated associations, a scheme has been adopted for the formation of research groups. These operate on the same basis as the associations in so far as finance and research programmes are concerned, but the work is undertaken in one of the existing laboratories of the Department by one or more scientists allocated to each group. Such a group is operating for the bacon-curing industry, and others are in the development stages.

Industrial Servicing.—Manufacturers have made extensive use of the special facilities of departmental branches for scientific services that are not available elsewhere in New Zealand. Valuable assistance on scientific and technological matters has been provided for industry in this way by the Auckland Industrial Development Laboratories, the Dominion Laboratory, the Dominion Physical Laboratory, and the Geological Survey, and by the Canterbury University College Industrial Development Department. Details of this work are reviewed periodically, and particular attention is given to the possibilities of private enterprise taking over some of the activities.

General.—Arrangements were made in three of the main centres for a visiting scientist to deliver addresses on electroplating research in the United States of America. In addition to other scientific matters of wide general interest to manufacturers, the Committee has given consideration to the industrial uses of radioactive isotopes for special testing, to research and scientific services for the printing trade, and to membership of New Zealand firms in overseas research associations.

UNIVERSITY COLLEGES

Grants were made by the Department to Canterbury and Massey Agricultural Colleges and to Canterbury University College.

CANTERBURY AGRICULTURAL COLLEGE

Director: Dr M. M. Burns

ANIMAL HUSBANDRY

Progeny Test.—The fifth progeny test was commenced in March 1951 and completed in October 1952. At the request of the Corriedale Sheep Society, the test ewe flock (which had been built up from daughters of rams in previous tests) was heavily culled to secure uniformity. The selected ewes that remained in the flock were sufficient to test eight rams. Of these two rams proved to be superior breeding, and were awarded Merit Certificates by the Society. The sixth test was commenced in March 1952 with five rams accepted for test.

The wet summer was responsible for delaying the shearing at both Rinaultrie and Eskdale, and no data were collected this year.

A study of the lifetime production of ewes in the Corriedale progeny test flock, the Rinaultrie Romney flock, and the Eskdale Corriedale flock has been completed. This paper has been accepted for publication in the *New Zealand Journal of Science and Technology.*

Nutritive Value of Hill Pastures.—This work has been extended to cover the chemical analysis of individual botanical species throughout a complete growing period. Samples of the different species were collected from an enclosure in the high-country tussock grasslands. The results have shown the differences between species, seasonal trends in composition, and a generally low level of nutritive value especially in regard to protein and phosphorus.

Detailed results of all this work have been forwarded for publication to the *New Zealand Journal of Science and Technology.*

ENTOMOLOGY

Red Clover Pollination and Seed Setting.—Scrim-covered plots planted out with red clover clones together with certain other flowering plants to provide an alternative source of pollen and nectar are being used for this work. A plan for pollination experiments, using insects—mainly bumble bees and honey bees—has been drawn up. Attempts have been made to establish bumble bee colonies in specially constructed nesting boxes as used successfully in Sweden. It is proposed to carry on this work over a period of years.

Studies on Persectania ewingi *Woodward* (Lepidoptera : Noctuidae).—Techniques have been developed for inducing egglaying by females in captivity and for the mass rearing of caterpillars. For the latter purpose a synthetic food to replace the normal diet of green leaves has been developed. Developmental phases have been found to exist in this species. Caterpillars reared under crowded conditions show distinct differences from caterpillars reared in

isolation. Ecological requirements of all stages of the insect are being investigated.

Thysanoptera *in New Zealand.*—Thrips from all types of plants are being collected and studied with a view to the publishing of a work on this order.

FARM MACHINERY

Harvesting of Small Seeds.—Construction of an experimental threshing machine for the rapid handling of threshing trials of small seeds is nearly completed. It can be used for stationary threshing, windrow harvesting, and direct combining. Samples of various seeds have been threshed to determine causes of damage, and the results are being analysed.

Investigation of Reactions of Mounted Ploughs Upon the Tractor.—Work on this project has been delayed owing to difficulty in obtaining measuring and recording equipment from overseas. This has now come to hand, and the investigation is proceeding.

PASTURES

Pasture Investigation on Light Land at Ashley Dene, 1952–53 Season.—Production of the different mixtures of grasses and subterranean clover has been measured. This season, influenced by the very dry autumn, resulted in a very poor establishment of clover, and this presaged a year of poor production which eventuated up to the end of September. From September, rainfall was above normal and growth on the area continued through to the end of January, resulting in one of the highest years of production experienced. The dry-matter production was over 5,000 lb. per acre in the better mixtures.

The behaviour of the different mixtures is in keeping with the reaction of subterranean clover to grass competition. The phalaris - lucerne - subterranean clover combination has maintained its place as the highest yielding mixture. The cocksfoot - subterranean clover mixture was lowest, probably because of the small proportion of clover in the stand. The phalaris - subterranean clover mixture continues to show compatibility.

The ryegrass - subterranean clover mixture has improved this year. This is associated with a less dense sward of ryegrass following the dry autumn and consequently better clover growth in the spring.

WOOL

Wool Survey.—Three papers prepared or in preparation embody the following findings: (*a*) there is a consistent fall in fleece weight with increasing fineness of wool; (*b*) there are highly significant differences between flocks and breed groups in the rate of fall in fleece weight; (*c*) rate of fall in fleece weight is of great significance when considered along with price differences; and (*d*) incidence of environmental wool faults in New Zealand is high, whereas serious hereditary faults have low incidence.

Fleece Rot.—Detailed examination of the fleece suggests that predisposition on the part of the animal differs between the Corriedale and the Merino. Fleece analysis is proceeding.

MICROBIOLOGY

Soil Microbiology.—Quantitative differences have been shown in the rhizosphere-to-soil ratios of organisms associated with lucerne varieties, and the significance of this is being examined in relation to plant nutrition and vigour.

In studies on *Rhizobium* bacteria, other associated organisms were found in healthy clover root tissue and tentatively identified as *Aerobacter cloacae,*

Bacillus megatherum, and *Flavobacterium rhenanus.* Strain differences were found in *Rhizobium* in subterranean clover root nodules, and the distribution of these recorded in 19 soils.

In studying nitrogen metabolism of the fungus *Cercosporella herpotrichoides* it was shown that inorganic nitrogen salts could be assimilated in succinic-acid buffered media. Organic nitrogen as peptone continued, however, to provide the most favourable nitrogen source. In growth studies on verticillium fungi, culture fluids are being examined for a toxic principle and amino acid excretion is being measured by chromatographic analysis.

Plant Pathology.—Severe attacks of the following diseases have been under investigation: wheat take-all (*Ophiobolus graminis*), tomato fruit-rot (*Phytophthora parasitica*), tomato stem-canker (*Didymella lycopersici*), potato pink-rot (*Phytophthora erythroseptica*—new record), and lily grey-mould (*Botrytis elliptica*). A survey is in progress on the significance of the disease factor in South Island oat crops.

On a field area known to be heavily infected with *Cercosporella herpotrichoides,* among 100 varieties and selections of wheat tested the following revealed a degree of tolerance to eyespot lodging that warranted further testing: Illini Chief Selection, from the United States of America; Selection 9 (*T. persicum*), from Cyprus; Hofed 3, from Australia; *T. vulgare erythrosperum,* from Uzbek; and Menno, from U.S.A. Standard varieties of wheat grown generally in New Zealand all showed a high *Cercosporella* disease rating.

LIME

A study is in progress on the rate of reaction, downward movement, and leaching of lime from the soil under Canterbury conditions, following the application of ground limestone to pastures on various soil types on the college lands, with two objectives. One is to test the effects of hardness, fineness of grinding, and soil type on the solubility of limestone in the top-dressed sward. The other is to study the effects of rate, fineness, and frequency of dressings on the retention and leaching loss of lime from the 0 in. to 6 in. horizon of two very different soil types. Information is sought on the effects of lime status and soil type on the economy of lime use. It is hoped to measure leaching losses of calcium by keeping a chemical balance-sheet over a period of six years.

A new study is being initiated on the factors concerned in the lime response of clovers by the comparison of response curves obtained from pot cultures under glass. A pilot trial on the necessary experimental conditions has been conducted. Specific objectives include a study of the form of the response curves over the full range from incipient response to depression by over-liming; the influence of levels of other nutrients on the lime response; and the comparison of different liming materials and the measurement of the lime requirement of different soils in terms of lime response curves.

CANTERBURY COLLEGE INDUSTRIAL DEVELOPMENT DEPARTMENT

Director: Mr T. R. Pollard

The Canterbury College operates this Department on behalf of the Department of Scientific and Industrial Research to provide technical assistance, research, and development for industry in the South Island. The Department makes an annual grant to the college to meet the deficit in the year's operations, which, by virtue of their development character, involves an approximately equal financial contribution from the Government and industry. The grant paid in

1952–53 was £7,750. Recoveries from industry amounted to £8,718. This includes work which was paid for in full by industry.

There was a considerable increase in industrial work over the past year; the number of projects handled for industry was 361 and the number for Government Departments 45. Whilst the increase is gratifying, the financial necessity of concentrating on work giving a fair percentage of financial recovery may, if developed too far, militate against this organization's true function of research and development.

The Canterbury College Industrial Development Department has continued to concentrate mainly on electrical and electronic devices for industry. Typical of the work undertaken are the following: for neuro-muscular research, formerly undertaken at Otago Medical School and now being undertaken at the Australian National University under Professor Eccles, the laboratories have constructed four electronic stimulators. These instruments have been most favourably commented upon by Professor Eccles and other authorities in this field. A considerable number of axles and steering links have been tested for the municipal transport authorities and for private firms, in which magnetic particle, supersonic, and dye-penetrant methods were used. The experimental work carried out in 1951–52 is showing a useful industrial application. An electronic device for giving warning to crane drivers when approaching high-tension lines has been developed and is under test by the Christchurch Drainage Board. A remote governor position indicator has been developed for the Christchurch Gas Co., and is at present being installed. A magnetic plotting board has been developed for a taxi firm to assist with the radio communication of their taxis. Investigation in the drying of silvered mirrors was carried out, and an infra red drying bank is being constructed. Experimental work on an automatic machine for the edge grinding of glass has been completed, and the design is proceeding of a machine to carry out this work.

MASSEY AGRICULTURAL COLLEGE

Principal: Professor G. S. Peren

Milk Supply of the Romney Ewe in Relation to Growth of the Lamb.—Records from the previous five seasons have been submitted to statistical analysis.

Wear in Sheep's Teeth.—A photographic chart of sheep's mouths was prepared and circulated to authorities throughout New Zealand in order to map out variations in teeth quality, and to attempt to relate them to external factors (soil, climate, management, etc.). Results from the previous five years' work with experimental groups of sheep in the Taihape and Manawatu areas (including the college farm) have been tabulated and statistically analysed. Chemical and physical tests on teeth and herbage are under way.

Roundworm Parasitism in Sheep.—Investigations were continued on the epidemiology of worm parasitism in sheep. Particular attention was paid to the possible inhibitory effect of various pasture plants on parasitism by the stomach worm *Haemonchus contortus*. Half-acre worm-free plots were specially laid down to the following clovers and grasses: white clover high in the glucoside lotaustralin, Ladino clover, red clover, cocksfoot, and short rotation ryegrass. Lambs reared from birth indoors, free from parasitism, were used, and following their being placed in the field were given known populations of the infective larvae of the stomach worm. Data were collected in terms of populations of worms found at post mortem. The work is being continued.

Sheep-breeding Experiment.—The collection of information to study the effects of interactions between heredity and environment on productive characters and to discover genetic antagonisms between characters is being continued.

A start has been made on an analysis of the inheritance of fertility in this flock, and also an investigation is being undertaken on the effect of wool covering on the face of the sheep in relation to its productivity.

The Genetics of Experimental Stocks of Hairy Sheep.—Building on the recognition of Mendelian factors with major effects, this research is mainly concerned with the mode of action of the factors and their interaction one with another. The methods used are: Mendelian breeding experiments, fibre type studies, and the mathematical techniques of population genetics. An important problem is the relation between hairiness and the growth rate and carcass characterization of lambs.

Farm Drainage Research.—Records of outflows from experiments already installed continue to be taken. New experiments include a study of the damage to tile drains resulting from the passage of heavy traffic, and the effect on pasture growth and drainage efficiency when subsoiling is carried out over deep mole drains. Investigations are projected to determine the proper depth and spacing of tile drains on some recent alluvial soils, and a study of the influence of drainage on the amount of run-off.

Manurial Trials Under Rotational Grazing.—This experiment, now in its fourteenth year, is the oldest grazing experiment in New Zealand. It is laid down with five replications of each of the treatments superphosphate (= super) at two rates per acre, basic slag, super plus lime, and super plus lime plus potash. Soil analyses confirm previous work that superphosphate, of which 2 tons 16 cwt. have been applied to some plots, does not increase soil acidity. Basic slag has had the effect of reducing acidity by an amount approximately equal to its own weight of ground limestone. About 5 cwt. per acre per annum of ground limestone is required to maintain limed plots, which have received 5 tons 5 cwt. of lime, at a constant low degree of acidity. The soil has increased in available potash on plots treated with this element, but without appreciable effect on plant growth. Molybdenum has given responses on small "pilot" plots.

Plant Propagation Research.—A new technique has been developed which very much simplifies the grafting of evergreen plants, and promises to bring about a great economy in that aspect of nursery work. A detailed study is being made of the mode of action of hormones on plant tissue from the points of view of both plant propagation and weedkilling.

Pampas Research.—The use of sheep in controlling the ground flora of a pampas area is being tried on the hill-country plots. A system of management that precludes browsing of the pampas is essential, because it is very sensitive to defoliation. The effect of cutting at different times of the year is under investigation, and results should be available in the coming year. So far there are no observable differences between deflowered and non-deflowered plants, and between those that have been burned after grazing against those not burned. Crosses have been made as a first stage in improvement.

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